HEATING AND VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH THE DESIGN AND APPLICATION OF AIR CONDITIONING, REFRIGERATION, PIPING, AIR SANITATION, HEATING AND VENTILATION IN BUILDINGS

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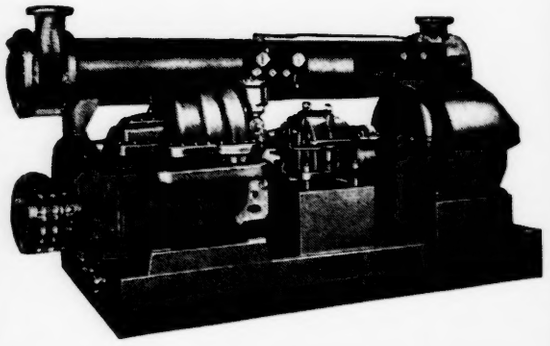
THIS MONTH'S COVER

Photographer Rod Yould climbed into the spray chamber of a cooling tower for this shot of a downspray distributing system. James G. DeFlon, chief engineer, Manufacturing Division, The Fluor Corp., Ltd., presents pointers on cooling tower maintenance in his article beginning page 57 of this issue.

what's at the bottom of efficient air conditioning?



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Washington News

LORING F. OVERMAN

AS the tumult and the shouting died in Washington with the closing of the 80th Congress, the Republican convention, the Louis-Walcott affair, and the Lewis-Operators coal episode, American industry—including producers of heating, ventilating and air-conditioning equipment—were beginning to awake to the realization that something new has been added.

That "something new" was a draft-industry amendment attached as a rider to the Draft Act itself. It was passed in the very closing hours of the Congressional session, and written into the law of the land when the President signed the draft legislation. As explained in this column last month, a rider is a sort of legislative parasite. It is usually a piece of controversial legislation (which probably would never get through under its own power) fastened onto some measure slated for certain passage. Frequently such riders are attached by opponents of the main bill, in the hope of making the entire subject such a hot potato that it cannot be handled at all.

In this instance, the Draft Act had to be passed, the Congressional deadline was at hand, and it was not too difficult to sell tired legislators the apparent logic of agreeing, "If you draft my boy, you must also draft business." Put that way, it was a tough argument to counter. So the rider rode. At month-end, Washington had not yet gotten over the idea of a Republican Congress making a surprise gift of drastic control powers to the Democratic Administration.

Congress Reverses Self

Until the passage of this rider, it had been generally supposed that the Republican Congress would continue to resist President Truman's request for authority to re-impose controls of any kind. Congress had previously fixed its position with regard to controls by passing the Taft-Wolcott Anti-Inflation Law on December 30, 1947. This law was intended "as an aid in stabilizing the economy of the United States, to aid in curbing inflationary tendencies, to promote the orderly and equitable distribution of goods and facilities, and to aid in preventing maldistribution of goods and facilities which basically affect the cost of living or industrial production."

All of these objectives were to be accomplished by voluntary means. The President was authorized to consult with representatives of industry, business, and agriculture with a view to encouraging the making of voluntary agreements approved by the President—

(1) providing for allocation of transportation facilities and equipment;

(2) providing for priority allocation and inventory control of scarce commodities which basically affect the cost of living or industrial production; or

(3) providing for regulation of speculative trading on commodity exchanges.

Voluntary Plan Affected

Under this voluntary plan, considerable progress had been made toward equitable allocation of scarce supplies of steel and pig iron. Programs for freight car construction and needs of atomic energy plants had been approved, and some of direct interest to readers of this column were in the making. In the housing construction field, for example, programs were under discussion by Industry Advisory Committees representing cast iron soil pipe, cast iron pressure pipe, warm air furnaces, plumbing drainage supplies, cast iron low pressure boilers, cast iron enamelware plumbing, soft wood plywood, and all-steel manufactured houses.

In response to the steel requirements schedule submitted by the Warm Air Heating Industry Advisory Committee to the Office of Industry Cooperation, the Steel Products Advisory Committee had recommended acceptance of the proposal that approximately 212,000 tons of steel be included in a proposed voluntary agreement for the industry for the eight months period ending February 28, 1949.

The Warm Air Heating Advisory Committee had stated that estimated requirements to meet the needs of the 1948 housing program are as great as last year's total production of 877,000 warm air furnace units, and the necessary related items to permit heating installations.

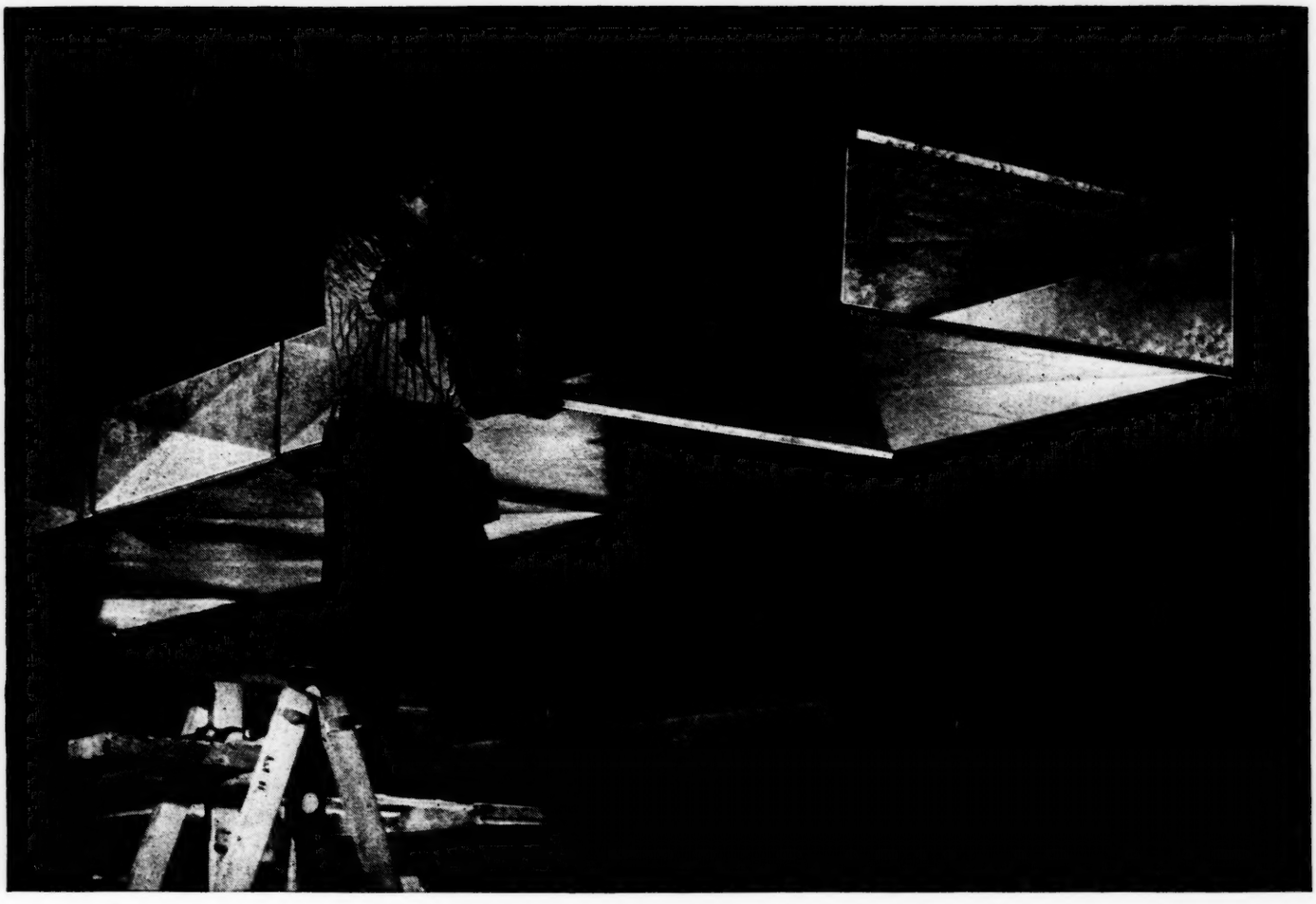
The OIC Building Materials Negotiation Division staff (of the Department of Commerce) was also working closely with advisory committees representing cast iron low pressure boilers and radiation.

Of similar interest to HEATING AND VENTILATING readers was the progress being made in analyzing requirements estimates submitted by the Petroleum and Gas Industry advisory committee. Among topics nearing the recommendation stage were programs involving pipe line requirements, oil and gas production requirements, manufactured gas and gas distribution requirements, facilities for marketing requirements, and refining requirements.

What Happens Now?

Washington had not completely digested the possible effects of the draft-industry amendment as July opened. Opinions varied from "It won't affect the voluntary program," to "It's the opening wedge that will eventually require allocation of all steel, plus price controls, plus etc. etc. etc."

In any event, the draft-industry amendment, included in Section 18 of the Draft Act, authorizes the President to allocate steel to manufacturers holding defense orders, to require industry to accept military orders and to fill them within the time he designates, and to seize any plant, mine or facility that does not comply. For officers of firms failing to comply, penalties may be $50,000 and jail sentences up to three years.



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As soon as the possible implications of the draft-industry amendment dawned upon the startled Administration, the White House called a hurried conference of heads of interested agencies. Top lawyers of the Military Establishment, the Munitions Board, the Department of Commerce, and the National Security Resources Board were having a field day pointing out possible ramifications.

Whither Steel?

Most specific of the provisions, it is agreed, is authority to give top priority to steel orders for holders of defense contracts. If the mandatory power is used by the Government—and the betting is that it will be—this means that steel producers will be permitted to fill other orders only after they have filled military needs. Congress apparently intended the grant of power to make it easier for small business to get military orders, but did not limit the President's power to helping small business. Instead, the allocations authority is unlimited as to steel for any and all defense work.

Small business demands, however, are expected to be so pressing that the President will undoubtedly issue an Executive Order directing military agencies to start allocating. Observers believe that the very first allocation of steel to a small manufacturer will open the flood gates and make certain that all steel going into defense orders will be allocated steel. They explain that, once the bars are down, no holder of a defense order will willingly use his own steel, obtained through regular channels, for defense work when he could be using that steel to handle civilian business. Instead, he will use his regular supplies for civilian manufacture, and insist that steel be allocated for defense orders.

Steel industry officials have expressed their fear that a mandatory defense allocation program, superimposed upon the voluntary program now being worked out, will completely disrupt production and delivery schedules. Government officials explain that defense program needs, as such, represent only a fraction of requirements at the height of World War II programs. They admit, however, that conditions at the start of the current program are vastly different than when the 1939-1940 program got under way. At that time there was a surplus of both manpower and facilities. Today, any defense requirements impinge upon production facilities already unable to meet the backlog of civilian requirements. Thus there is the possibility that allocation of even a relatively small amount of steel for military purposes would have a most serious impact upon civilian economy.

Speaking of Manpower

Some analysts of the draft-industry amendment surmise, among other things, that use of the authority will ultimately make itself felt in the field of manpower. They reason that the company having an assured supply of steel will be in a position to recruit labor at the expense of companies that must scratch and scramble for steel. Labor normally flows to companies that can promise steady work and overtime hours. The effect of the Draft Act itself, which is expected to remove nearly 400,000 men from circulation, should also be taken into consideration, along with the aircraft industry's need for 150,000 to 200,000 additional employees. Again, while the totals are not large, when taken from an economy that is enjoying full employment, the effect will not go unnoticed.

Unfinished Business

Members of Congress may find, when all reports are in on the scope of the draft-industry amendment, that they did more in the 80th Session than they had intended. They may even wish that the amendment, like the following legislative proposals upon which a lot of time was spent, had remained "unfinished business":

Inflation control measures; long-range housing programs, civil rights measures, federal aid to education, social security expansion, oleomargarine tax repeal, minimum wage increase, health insurance, universal military training, tidelands oil bill to turn the property back to the States, creation of a National Science Foundation, the Mundt-Nixon anti-Communist bill, equal rights constitutional amendment, abolition of the electoral college constitutional amendment, Statehood for Hawaii and Alaska, District of Columbia home rule.

All of these measures had been labeled "musts" and had undergone lengthy hearings by committees in both houses. Unless the 80th Congress is called back into special session, all of these measures will have to start all over again when the 81st Congress convenes on January 3.

New Housing Bill Inadequate

A housing bill passed in the closing hours of the 80th Congress as a substitute for the ill-fated Taft-Ellender-Wagner housing measure, does only two things to promote residential building. It permits the Government to buy mortgages guaranteed by the Veterans Administration and the Federal Housing Administration from banks and other lenders, so that they will not become overloaded and shut down on credit. It also permits the FHA to insure up to 95 percent of loans for nonprofit veterans' cooperative housing projects.

The measure does not revive the wartime Title VI mortgage insurance under which about one-third of all housing was financed until it expired on April 30. Neither does it contain the provision for Title VI insurance of large-scale rental housing projects.

Until Congress meets again, there will be no Federal stimulus to slum clearance, public low rent housing, farm housing, residential building research, or "yield insurance." Under the expired Title VI, FHA insured mortgages on dwellings up to 90 percent of the current cost of construction. What remains is Title II, which also provides 90 percent insurance, but only on the long-term economic value of the dwelling. Title VI not only aided prospective home owner, but also helped builders obtain financing to start new projects.

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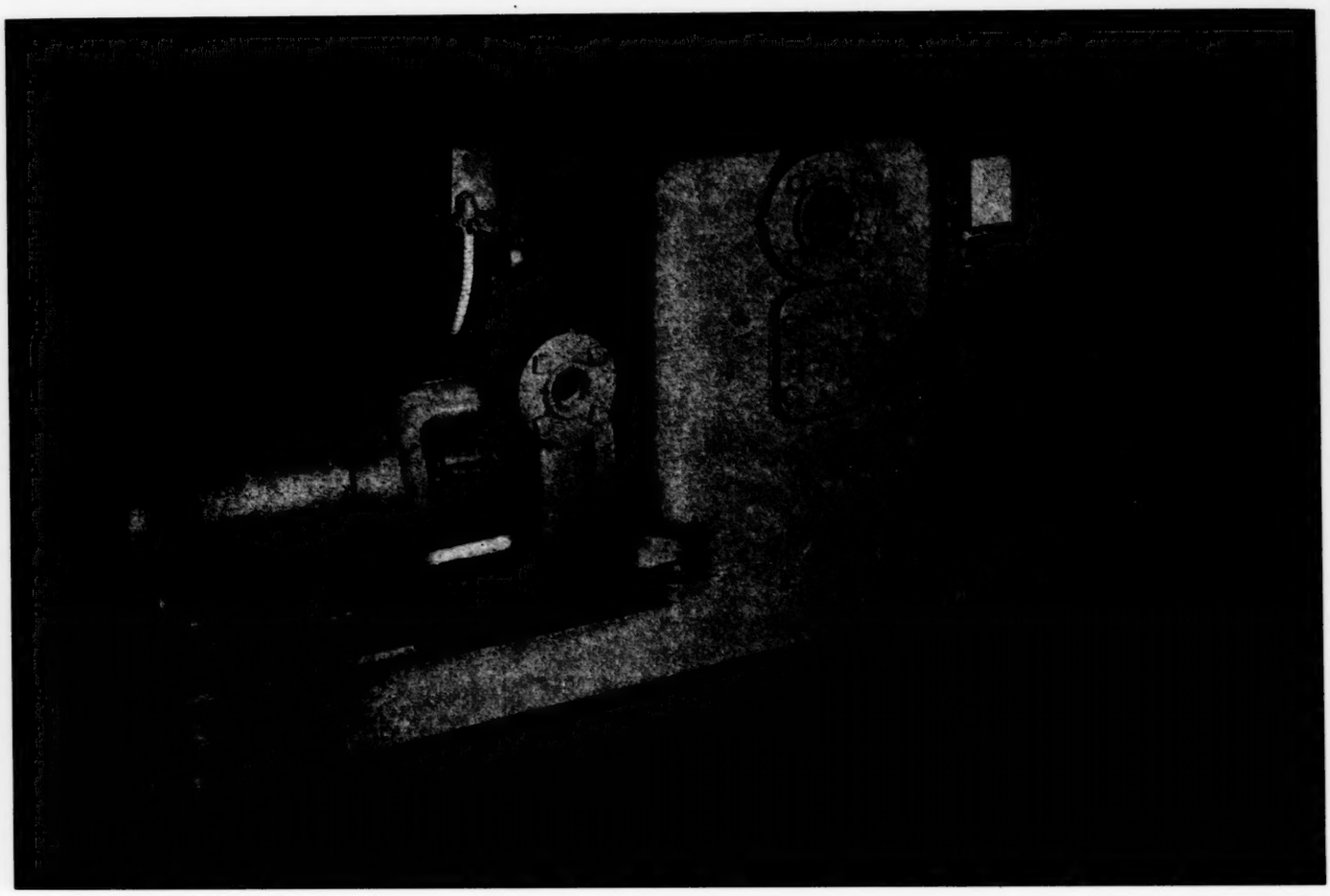

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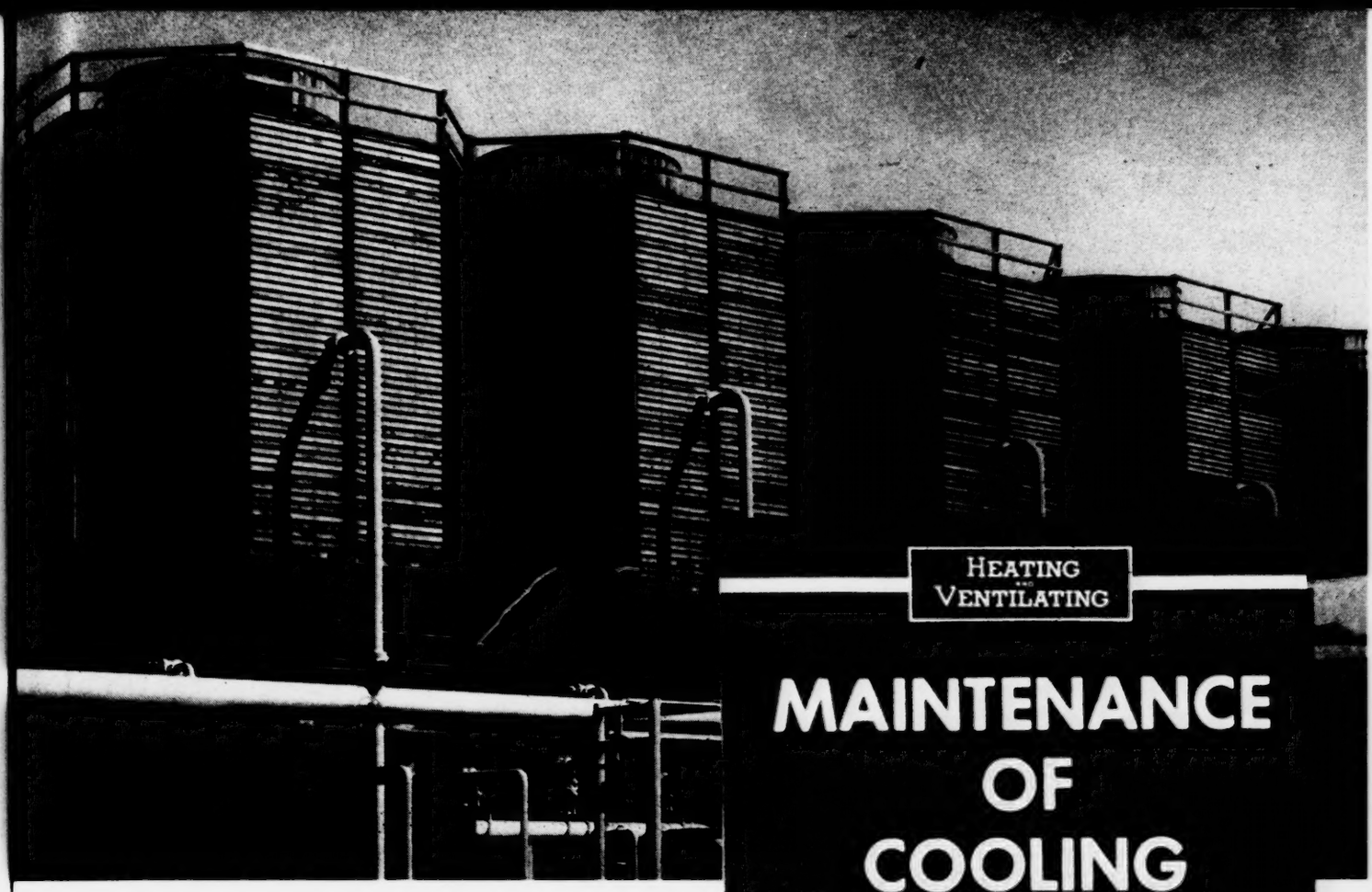


HEATING AND VENTILATING

MAINTENANCE OF COOLING TOWERS

JAMES G. DeFLON

If a cooling tower is allowed to get into a state of disrepair, its performance is seriously affected and the cost of repairs increased. Mr. DeFlon tells what danger signals to look for and what steps can be taken to prolong the life and increase the efficiency of various types of cooling towers. The author is chief engineer, Manufacturing Division, The Fluor Corporation, Ltd., Los Angeles, California.

COOLING tower maintenance is a subject which, in the past, has not received sufficient attention from plant operators. In most plants there is a program of preventative maintenance for all operating equipment, and such a program should certainly be extended to include cooling towers. There is little doubt that the inaccessible location of most towers, either on a roof or on the outskirts of the plant, is responsible for this. However, it should be remembered that an adequate supply of cold water is most essential for satisfactory and efficient plant operation.

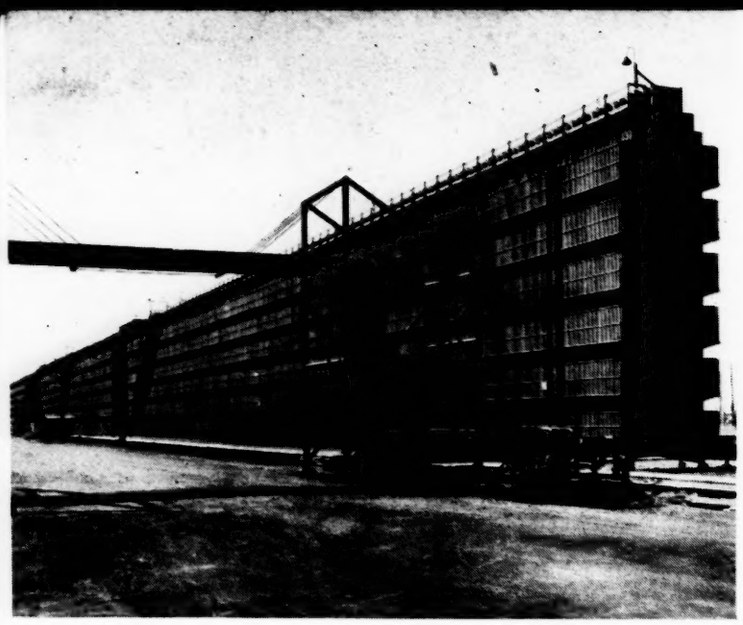
The very principles upon which the cooling tower functions also give rise to the problems of its maintenance. For instance, in order to obtain the desired cooling of circulating water, it is necessary that evaporation take place, and this creates a new problem by increasing the salt content of the water.

In order to perform satisfactorily, cooling towers are usually installed in open, unobstructed areas where wind velocities are such as to allow dust, dirt and debris to be carried along. Since the air passes through the tower over which water is falling, the debris would be washed out of the air and into the basin, and another problem is created.

In order to keep the salt content of the water in the basin to an absolute minimum, and also to remove any collected dirt, dust, and other debris from the basin, it is recommended that a continuous blow-down be made a part of the cooling tower system, and that the tower be scheduled for periodic shut-downs so that the internal filling of the tower and the basin can both be cleaned.

Water Treatment

In discussing the maintenance of a cooling tower, it is well to remember that the maintenance of the tower, exclusive of any mechanical equipment, is closely associated with the quality of the water used. It is therefore almost impossible to discuss cooling tower maintenance without discussing cooling water treatment. The problem of water treatment is an entire field in itself. The following is the general opinion of a number of plant operators and is not intended to be a solution to a specific water treatment problem, but is to be used only as a guide in this matter. For specific problems, it is recommended that any one of a number of companies specializing in water treatment be contacted. Briefly, however, water treatment is done to control algae, to control scale formation, and to prevent deterioration of the materials used in the construction of the equipment.



Aerator tower with balcony-like drift eliminators.

Many operators have found chlorine to be one of the most suitable agents for the control of algae. In many plants satisfactory algae control is obtained by injecting six to eight pounds of chlorine per day for each 1,000 gpm circulated. If this amount is consistently added to the water, however, a type of algae immune to chlorine will soon develop. Therefore, every ten days or so for a short period of time the amount of chlorine supplied to the system should be increased several times, thus preventing chlorine immune algae from developing.

Generally speaking, by controlling the pH of the cooling tower water, it is possible to control the rate of scale deposition in piping and on exchanger tubes. The higher the pH of the water, the greater the tendency for a scale to deposit. When the pH is below seven, little or no scale deposition occurs; rather, the metals in contact with the water slowly begin to dissolve. The latest most satisfactory practice is to keep the pH of the water between 6.5 and 7, and then to add a corrosion inhibitor to the system. This keeps the piping and exchanger tubes clean, and prevents the metal from corroding. However, the above treatment should only be attempted under the advice of a water treating specialist.

In certain areas of the Western United States, the water tends to be very alkaline due to the presence of sodium, calcium, and magnesium salts occurring in the form of bicarbonates. This situation is further aggravated as the cooling tower tends to concentrate the salts in the system. It has been found that when the pH of the water is over 9.0, and when large amounts of bicarbonates are present, the structure of the wood in the cooling tower may be seriously affected. It is particularly noticeable where the wood is alternately wet and dry, a condition which occurs on the sides of an atmospheric tower. At these points the bicarbonates concentrate and turn into normal carbonates. The carbonates attack and dissolve the lignin in the wood, producing an effect which is termed delignification. This is evidenced by a soft, spongy, stringy wood structure which appears to be decayed. The only way delignification can be absolutely prevented is to remove the bicarbonates from the circulatory system. This is impractical in many cases. However, plant operators report delignification can be controlled by keeping the pH of the water below 8.5.

Once the importance of the water problem is understood, the operator should next consider the scheduling of a regular inspection and maintenance program for his cooling equipment. This regular inspection program should include the distributing system, filling, outside covering (paneling, louvers or aerators, and drip panels), framework, basin, drift eliminators, coilshed sections and mechanical equipment.

Distributing System

The importance of maintaining the distributing system at peak efficiency cannot be over emphasized. The function of the distributing system, as the term indicates, is to distribute the water uniformly over the top of the tower and to break it up into fine particles in order to expose as much water surface as possible to the air. There are four general types of distributing systems in common use today, namely, the upspray, the downspray, the flume systems and pantype systems. However, before discussing the specific types of systems, it is well to point out that, regardless of the type of system employed on new towers, it will be necessary to inspect the nozzles every week or two for the first three months of operation. That is, to make sure that any wood splinters, shavings or other debris normally found in a new tower have not plugged some of the nozzles.

The upspray system consists of a central header with pipe sidearms to which, at regular intervals, are attached the upspray nozzles. This system ordinarily operates at five to six pounds nozzle pressure, and depends on centrifugal force rather than small orifices for fine breakup of the water. The nozzle orifices are usually about one inch in diameter. This large opening, together with the five or six pounds pressure drop is sufficient to prevent algae, small rocks and sand from plugging the nozzles. The system is usually located about six or eight feet below the drift eliminators on mechanical draft towers, and about the same distance from the top of an atmospheric tower. The nozzles spray up and completely fill the spray chamber with finely divided water. This type of system will distribute the water uniformly with a wide variation of water flow. This system requires a minimum of attention, but should be inspected every nine to twelve months and any obstructions in the nozzle should be removed. This inspection, of course, is predicated upon the fact that the customer inspects the system as mentioned above during the first two or three months of operation.

The downspray system consists of a central header with pipe sidearms to which, at regular intervals, are attached downspray nozzles. This system is usually located as close to the top of the tower as possible and operates on about 1½ lb nozzle pressure. Because of the low pressure, the nozzle must operate on the principle that water impinging on a plate will be distributed evenly. This system will perhaps not keep itself quite as clean as the company system; however, it too

will uniformly distribute water with a wide variation of water flow. This system should also be inspected every three to six months.

The flume type system is composed of a main flume extending around the outside of the cell with interconnecting side flumes. This flume is usually constructed of wood. In the bottom of the flume, holes are usually bored into which are inserted plastic discharge tubes. Two to three feet directly below each discharge tube is a plastic splash plate upon which the discharge stream from the flume impinges. The effect of the stream of water falling on this plate causes a splashing action which distributes the water. Flexibility of this system is limited by the fact that at very high water rates the flumes overflow and at reduced water rates the water is not uniformly distributed. Wooden flumes may open up at the seams if wetting is not constant, and they require leveling. Splash plates should be adjusted so that the stream of water impinges directly on the center of the disc. When sludge, algae and sand accumulate in the flumes, they require cleaning. This type system should be inspected every thirty days and repairs made immediately. If the tower is allowed to get into a state of disrepair, its performance will be seriously affected, and the cost of making repairs will be increased.

Another type of flume system is the open pan type, which covers the effective part of the cooling tower. In this type a large number of small nozzles, operating at an extremely low water head, are used. These easily become plugged with small pieces of debris. This type of system is susceptible to increased algae growth, due to the hot water temperature, and to its exposure to direct sunlight. By placing a cover over the distributing system, much of the debris blown in by the wind can be eliminated. This will also retard algae growth, since it shields the water from direct contact with sunlight. If covers are provided for the system, inspection should be made every two or three months; if not, inspection should be made more often.

Filling

The function of the filling is to increase the contact between air and water, primarily by offering new exposed surface to the air as the water cascades through the tower. Another function is to maintain proper distribution of both air and water. Its efficiency is affected by oil, dirt, algae and other foreign materials, and it is, therefore, important that the filling be kept clean. A filling composed of flat horizontal slats is more subject to the collection of foreign matter than are the decks composed of vertical or sloping slats. Sagging filling tends to concentrate the water in the areas of the low spots of the fill. This in turn causes air channelling since the air will not as readily pass through areas of high water concentration as through areas of low water concentration. This air channelling reduces the contact between air and water, thereby reducing the performance.

There are a number of different types of filling used. In general, they fall into two classes: the grid type and the slotted lath type. The grid type consists of boards or battens nailed upon cleats to form panels. These panels or grids are usually substantial enough to function as scaffolding during the period of erection, and are convenient to walk upon when cleaning and inspecting the tower. The grids are easily removed and are substantial enough to be cleaned with a fire hose.

The slotted lath type of fill consists of slotted lath, through which are threaded other lath. This type of filling is not nailed and should not be walked upon. It also cannot be readily removed nor should it be cleaned with a fire hose.

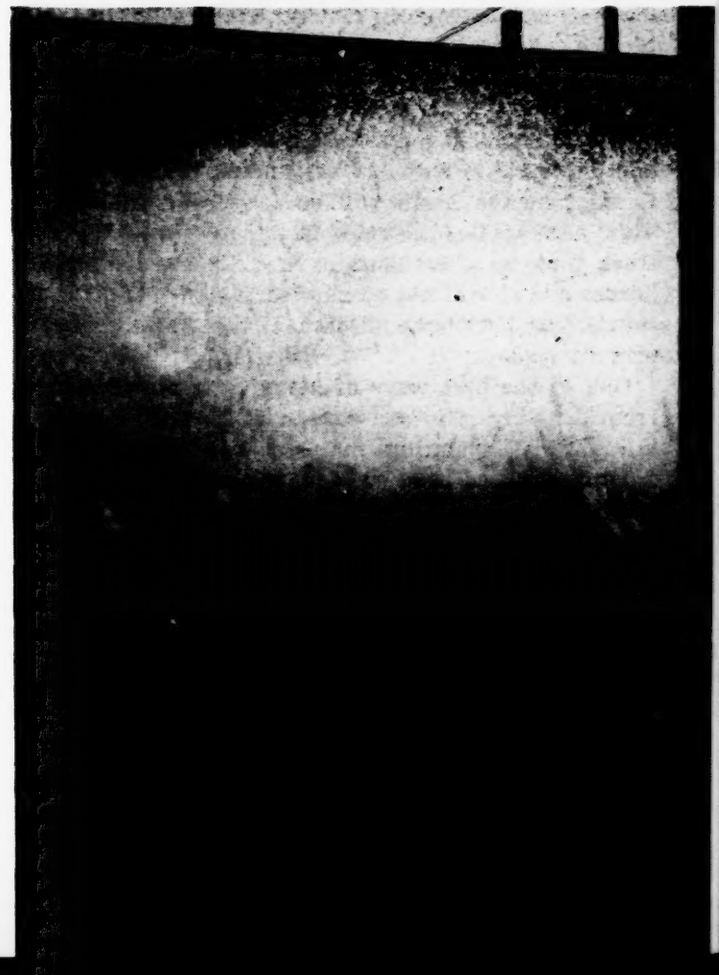
The presence of oil in the cooling tower water is detrimental to tower performance. This is because the oil soaked filling will not be wetted by the water. This results in improper breakup of the water and a reduction in the wetted surface exposed to the airstream. Oil deposits have been removed from the filling by means of solvents and steam. However, it is usually cheaper to replace the filling.

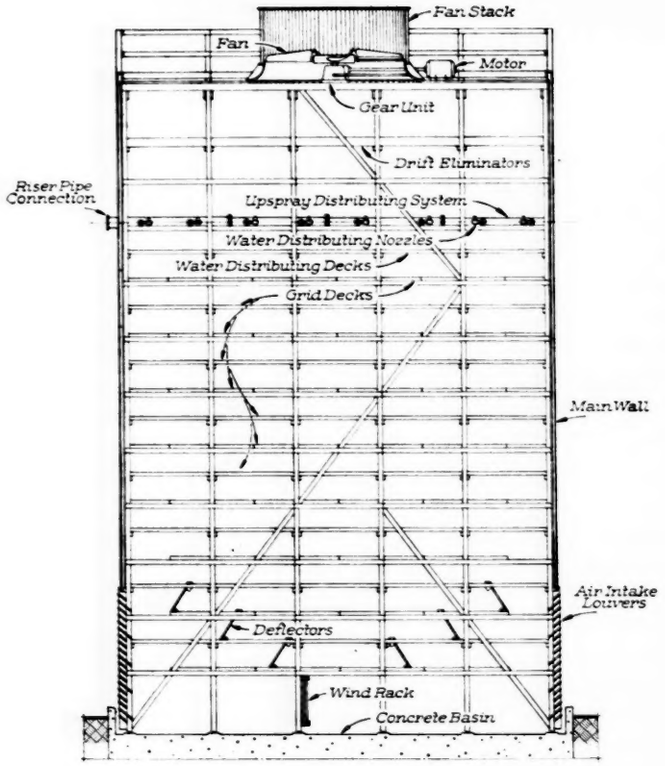
Cooling Tower Basins

Algae growth probably contributes more to reduce the performance of cooling towers than any other factor. Once algae has made headway there is very little to do but to shut down the tower and do a thorough cleaning job. This is usually accomplished by means of a fire hose and/or circulating a strong chemical solution. This should be immediately followed by a flushing and draining of the entire cooling system to prevent fouling of the heat-exchanger surface by the dead algae.

Cooling tower basins are usually constructed of concrete. They are also made of redwood and steel.

Upspray distributing system in operation.





Cross section of counterflow tower.

Occasionally one will find that the water circulated in the tower will have a detrimental effect on the concrete basin; in such cases, it has helped to plaster the basin with an asphaltic material similar to roof putty.

When cooling tower basins are constructed of redwood, it is difficult to maintain a water-tight basin. This is particularly true when a tower is used seasonally such as in connection with an air conditioning system. A redwood basin should never be allowed to dry out, as a change in moisture content of the wood is followed by a change in its dimensions. If redwood is allowed to dry and shrink, and then to soak and swell, it will be found that the wood will never quite revert to its former dimension. Therefore, if this wet and dry cycle is repeated very many times, it will be found that the basin will no longer be water-tight. This also applies to redwood stave pipe. Redwood stave pipe is often used as a primary distributing header and should not be allowed to dry out. Also, the reinforcing bands should be kept tight at all times to prevent leakage.

One of the best ways of stopping a redwood basin from dripping is to add shredded asbestos, similar to the fibrous insulating material used in plastering fractionating columns, to the area of the basin containing the leak. This shredded fibrous material will then migrate to the area of the leak and it will flow into and seal the crevice.

Suction pit screens should be incorporated in all cooling tower basins. They strain extraneous matter out of the cooling system, and do much to reduce the maintenance of the circulatory system.

An attempt should always be made to keep the water level in the basin above the level of the anchor bolts, and anchor castings. The interfacial surface between the air and water has been found to be very corrosive. Inspection shows accelerated corrosion to occur at the water line when very little, if any, occurs above and below this point.

Mechanical Equipment

Because failure of any part of the mechanical equipment (such as the fan, gears, or flexible coupling and floating shaft) will shut down the unit, it is important that a regular inspection and maintenance program be adopted. Here is a minimum service schedule for the various pieces of apparatus.

Gear. The oil level in the gear should be checked every thirty days. If it is found that the level has gone down, the gear case and oil seals should be checked for leaks, and appropriate steps taken to correct them. If, on the other hand, the oil level appears to have risen, drain a one quart sample from the bottom of the gear case and check for emulsification and contamination. Because the gear on an induced draft tower is located in a hot, humid air stream, condensation of moisture may occur in the gear case. This is particularly true in towers which are operated intermittently. Should there be any signs of emulsification, the oil should be drained and refilled with the type of lubricant recommended by the manufacturer. Also, an inspection should be made of the oil seals, particularly the oil seal on the slow speed shaft. Since oil seals are normally inserted in a small recess in the housing, it collects the moisture condensed on the fan shaft. Any failure of the seal, or corrosion on the shaft at this point, will permit the collected water to enter the unit.

An oil sample should be drained from the bottom of the gear case every three months. Again, if the oil shows any sign of emulsification, contamination, or deterioration, it should be drained and refilled. The oil should be drained and refilled every six months with the lubricant recommended by the manufacturer.

Once a year the oil seals on the gear should be examined and replaced if necessary. Also, the bearings should be checked for play, particularly the bearings on the fan shaft where the greatest wear usually occurs. This can easily be checked by rocking the fan blade up and down. If any appreciable wear has occurred, the bearing should be either adjusted or replaced. Where oil is found to be emulsified in the gear unit, indication of excessive wear will usually be found on the lower slow-speed shaft bearing. This is because on some reducer designs sufficient sump capacity for collecting water and sludge is not provided below the lower main bearing. If this condition exists, some relief can be obtained by substituting a large capped reducing nipple for the drain plug in the center of the gear case, thus allowing room below the bearing for the water to settle.

Couplings. The floating shaft couplings used on cooling towers fall into three classes: gear type, metal, fabric or rubber disc type, and the universal joint.

The gear type coupling should be taken apart and inspected once a year. The lubricant, together with any contaminants, should be drained and discarded. The teeth on the coupling should be washed with kero-

sene and examined for wear before reassembling. Care should be taken in the choice of a lubricant for this gear type coupling since it operates in a hot, humid air stream and there is danger of moisture condensing inside. As moisture condenses, the centrifugal action of the revolving coupling causes the water to displace the lubricant in the periphery of the housing. Since the gear teeth are also located on the housing periphery, serious wear may occur because of lack of lubrication. Because of this it is recommended that the lubricant used be of the water-proof type whose specific gravity is greater than that of water.

The disc type coupling should be examined every six months for cracks and breaks in the fabric or metal discs. Should they show any signs of wear, the discs should be immediately replaced. It is recommended for all couplings that heavy strap iron guards be made for each end of the floating shaft to confine the rotation of the shaft should the couplings fail. This is done to prevent the loose end of the shaft from whipping around and damaging the fan, as well as the motor and gear shafts.

The universal joint type coupling requires lubrication every three to four weeks. This type of coupling requires a heavy oil rather than a grease. Properly lubricated, this type of coupling will give excellent service since its flexibility adapts it for use on a wooden structure which may not be entirely rigid.

The gear and motor should be checked for proper alignment once a year. The following procedure for aligning floating shaft coupling is recommended:

The floating shaft and couplings should be removed, leaving a flanged hub on both the motor and gear shaft. Stretch a fine copper wire or chalk line over the top of both the motor and gear flange. Next, check with a square against the flange face and wire, first on one coupling and then the other. The square will show any misalignment. This should be done both with the wire or chalk line on top of the coupling and on the side of the coupling. Shifting of the motor and gear and shimming will make one edge of the square parallel with the wire in both positions. When this is accomplished, the unit will be in proper alignment.

Fans. The fan blades used on cooling towers fall into three classes: (1) fabricated carbon or stainless steel, (2) cast aluminum, or (3) airplane wing section type.

Once a year the fan blade arms should be examined for fatigue cracks; this applies to all classes of fans. The fabricated stainless steel fan should require little or no maintenance while the carbon steel and aluminum fan blades may be scraped and coated each year or two with a preserving material. On the other hand, carbon steel and aluminum fans have been known to give five to ten years of service with no maintenance work on the blades whatsoever.

The airplane wing type of fan blade consists of struts covered with fabric or metal. This type should be examined every three to six months for tears or rips in the covering. Should this occur, repairs should be immediately made lest the entire fan be destroyed.

A fan will become sufficiently unbalanced in normal service to require rebalancing every three to five years. This occurs because of the uneven erosion, corrosion, or deposition on the blades over a period of years. Very often, vibration on top of a cooling tower will be blamed upon the fan when, in reality, it is due to misalignment of the gear and motor. These two vibration sources can be readily distinguished. The vibration caused by an unbalanced fan will give a swaying motion to the tower because of its relatively great mass and slow speed, while the misalignment of the motors and gears will cause a high speed vibration which makes a rapping sound.

In conclusion, we may summarize by saying that the following is a minimum maintenance schedule for an atmospheric tower.

Once a week:

Inspect suction pit screens and clean as required.

Once a month:

Inspect flume type distributing systems and clean as required.

Once every three months:

Inspect and clean downspray distributing system.

Once every six months:

Inspect and clean upspray distributing system.

Once a year:

Shut down tower and thoroughly clean, particularly the distributing system, filling and basin. A thorough inspection of the structure together with the filling, louvers and aerators should be made at this time. Any repairs required should be made immediately.

The minimum maintenance schedule for a mechanical draft tower is outlined below:

Once a week:

Inspect suction pit screens and clean as required.

Once a month:

(1) Check oil in gear case for level and contamination.
(2) Lubricate universal joint type couplings.
(3) Inspect and clean flume type distributing systems.

Once every three months:

(1) Check downspray distributing system and clean if necessary.
(2) Inspect disc type couplings for fractures in discs.

Once every six months:

(1) Drain and refill gear case with recommended oil.
(2) Lubricate motor bearings.
(3) Check upspray distributing systems.

Once a year:

The tower should be shut down and thoroughly cleaned from top to bottom, including the basin. A thorough inspection of the structure should be made, together with the necessary repairs and replacements. Mechanical equipment should be checked for alignment and the bolts anchoring this equipment to the tower should be tightened. Fans should be inspected and repaired as required. Gear type couplings should be opened up for inspection and serviced and gear box bearings and seals examined for wear.

Radiation and Total Heat Transfer in Panel Heating

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In panel heating, the floor, wall, or ceiling is a heat source just as in a conventional system a radiator is the heat source. This heat must be transferred to the air in the room, to the surroundings of the room, and to the occupants of the room, and is accomplished by conduction, convection, and radiation. In this article is presented a discussion of radiant heat transfer.

Nature of Radiant Energy

Energy is continuously radiated from all matter whose temperature is higher than absolute zero,

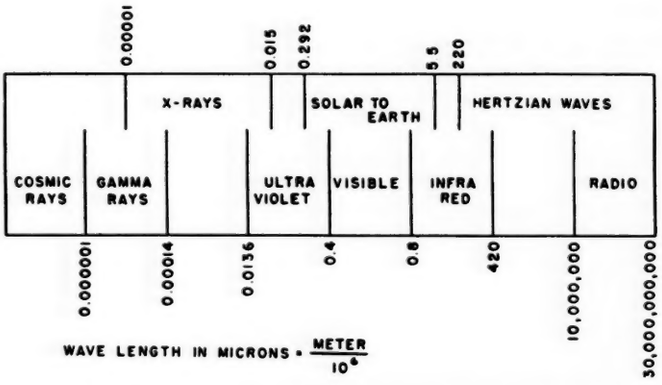


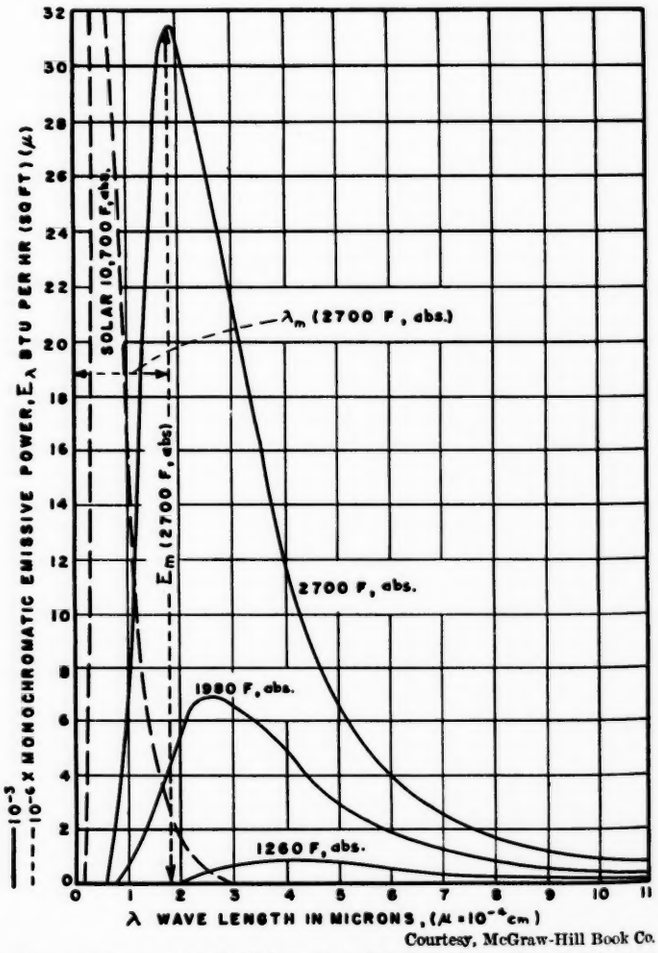
Fig. 1. Diagram of the electromagnetic ether spectrum.

— 460F. The rate of emission depends upon the temperature and the nature of the matter. Energy is radiated from every point of every surface in straight lines in all directions at a velocity of 186,284 miles per second (in vacuo). It does not require the presence of any matter for its transmission. For example, the earth receives radiant energy of widely varying wave lengths from the sun even though separated from it by an almost perfect vacuum.

Radiant energy is propagated in waves, analogous to electromagnetic wave motion, over a wide range of wave lengths that are distinguished by such terms as radio waves, heat, light, X-rays, etc. Fig. 1 shows the electromagnetic ether spectrum as divided according to these classifications. In the range between about 0.4 and 0.8 microns (a micron is a unit of wave length equal to one-millionth of a meter) the optical nerves are so tuned that the radiant energy appears as light.

The visible radiation which affects the eye will also affect a thermometer or other sensitive detector of heat and will appear as heat, if absorbed by a body, rather than reflected, refracted, or transmitted through that body. The longer wave lengths, up to about 420 microns, form a part of the spectrum called the infrared which contains the waves of greatest energy and which appear as sensible heat upon being absorbed by a body. This range is commonly called radiant heat because of all the energy that impinges on a body, that proportion that contains wave lengths between the above limits goes into internal energy. It accelerates the molecular motion in that body by increasing the kinetic energy of the molecules and, therefore, appears as an increase in body temperature.

Since energy radiation is an electromagnetic phenomenon it can be analyzed in terms of wave motion. It has been found experimentally that for each temperature and wave length there is a maximum intensity of radiation that is not exceeded by any surface. The curves representing this maximum intensity of radiation for a black body at four different


SOLAR 10,700 F, abs.
λm (2700 F, abs.)
Em (2700 F, abs.)
2700 F, abs.
1980 F, abs.
1260 F, abs.
MONOCHROMATIC EMISSIVE POWER, Eλ BTU PER HR (SQ FT) (μ)
λ WAVE LENGTH IN MICRONS, (1μ = 10^-4 cm)

Courtesy, McGraw-Hill Book Co.

Fig. 2. Energy distribution of a black body. By permission from Introduction to Heat Transfer by Brown and Marco. Copyrighted 1942, by McGraw-Hill Book Co., Inc.

temperatures are given in Fig. 2 and are derived from what is known as Planck's equation. It may be seen from Fig. 2 that as the temperature is lowered the energy distribution curve, and the position of maximum intensity for each curve, is shifted to the right. This shift of the position of maximum intensity follows a well established law called Wien's displacement law which can be used to determine the wave length corresponding to this position for any particular temperature.

Thus, the wave lengths of the radiation from the sun are relatively short and have a maximum intensity of about 0.48 microns, which is the wave length of blue light. A surface at about steam temperature will have most of its energy radiated at wave lengths around 8 microns, which is well into the infra-red. The radiant energy emitted, therefore, by a surface at temperatures such as are used in panel heating, approximately 100F, is by no means comparable to that given off by the sun, being of extremely low intensity, not large enough to show in Fig. 2, and toward the upper extreme of radiant heat wave lengths. There are no healthful ultra-violet waves involved in panel heating and there is no therapeutic value in the radiation emitted. In fact, as has been indicated, the radiation from a common radiator is of slightly higher intensity and contains shorter wave lengths than the radiation emitted by a panel.

The major difference between a conventional system and a panel system has to do with the percentage of the total heat transfer that is emitted by radiant energy but not as to its intensity or its wave lengths. For instance, in a conventional radiator system from 15 to 40% of the total heat transfer from a radiator may occur by radiation. In a panel system, such as a ceiling panel, as much as 80% of the total heat transfer may be by radiation because of the large area of the panel rather than its intensity per unit area.

Panel heating should not be confused with radiant heating. In panel heating systems the sensible body heat loss is maintained by both convection and radiation. The term radiant heating should be reserved for those systems which offset all of the radiant heat loss from the body, such as by the use of small high temperature sources, and hence allows all of the sensible body heat loss to occur by convection alone. True radiant heating systems are expected to appear in the future in factory and industrial heating where a substantial saving can be realized by maintaining a lower air temperature than in a conventional system.

Evaluation of Energy Exchange

The discussion so far has been devoted to the nature of radiant energy emission. It is desired, however, for practical purposes, to develop the equations that will evaluate the net energy exchange between a body and its surroundings or between the surfaces.

According to the Prevost theory of energy exchanges, all bodies at temperatures above absolute zero are continually radiating energy to their surroundings, even though at the same time they are absorbing more energy than they emit. For practical purposes, it is usually the net exchange of radiant energy between a body and its surroundings, or between two surfaces, that is significant.

On encountering any matter, radiant energy may be partly absorbed and converted into heat; it may be partly reflected; or it may be transmitted through the matter. The net rate of radiant energy exchange

Table 1 — Emissivity of Miscellaneous Surfaces

Type of Surface	Emissivity e	Degrees F	Reference
Asbestos Board	0.960	74	B
Asbestos Paper	0.930	100	A
Black Body (Theoretical)	e = 1.000 at any temperature		
Brick, Rough	0.930	70	B
Carbon, Lampblack, 0.003 in. min.	0.945	100	A
Enamel, White Fused, on Iron	0.897	66	B
Glass, Smooth	0.900	100	C
	0.937	72	B
Marble, Light Gray, Polished	0.931	72	B
Oak, Planed	0.895	70	B
	0.910	100	C
Paints:			
Acetylene Soot	0.990	125	C
Aluminum (Values Vary with amount of Lacquer Body and Age)	0.270 0.670	212	B
	0.650	100	C
Black Lacquer	0.800	100	A
	0.950	200	A
	0.800	125	C
Bronze	0.510	100	C
Flat Black Lacquer	0.960	100	A
	0.980	200	A
Lampblack	0.960	125	C
Oil Paints, All Colors	0.920 0.960	212	B
	0.920 0.950	200	C
White Enamel	0.920	125	C
White Lacquer	0.800	100	A
	0.950	200	A
Plaster, Rough Lime	0.910	50 190	B
	0.910	100	C
Porcelain, Glazed	0.924	72	B
Metals:			
Aluminum, Polished	0.040	100	C
Aluminum, Rough	0.055	78	B
Aluminum, Oxidized	0.110	100	C
Brass, Polished	0.096	100	A
	0.050	100	C
Brass, Oxidized	0.610	100	C
Silver, Polished	0.022	100	A
	0.010	100	C
Steel Plate, Rough	0.945	100	A

King—"At ordinary temperatures, most non-metallic solids, such as porcelain, glass, paper, cloth, building materials, and enamels and paints of any color, have emissivities in the neighborhood of 0.90 to 0.95."

A—Heilman—from original investigations.

B—McAdams—compilation of results of various investigators.

C—Croft—compilation of results of various investigators.

Other sources, such as the International Critical Tables and various articles on radiation, were investigated but the deviation from the above main sources was so slight that they were not included.

The above values for emissivity are not correct when referred to solar radiation since the color of the surface is then an important factor in determining the *e* value.

Table 2—Heat Emission by Radiation to Surroundings at Absolute Zero

$q_r = 0.173 \times 10^{-8} F_e T^4$

$F_e = 1.00$ and 0.90

Surface Temperature, F	Heat Emission Btu per (sq ft) (hr)		Surface Temperature, F	Heat Emission Btu per (sq ft) (hr)	
	1.00	0.90		1.00	0.90
60	126.3	113.9	90	158.5	142.7
61	127.1	114.5	91	159.6	143.7
62	128.2	115.4	92	160.8	144.7
63	129.1	116.3	93	161.8	145.6
64	130.1	117.2	94	163.0	146.7
65	131.0	118.0	95	164.4	147.9
66	132.1	118.9	96	165.5	148.9
67	133.0	119.8	97	166.7	150.0
68	134.0	120.6	98	167.7	150.9
69	135.0	121.6	99	168.8	151.9
			100	170.3	153.2
70	136.0	122.4	101	171.6	154.4
71	137.0	123.4	102	172.8	155.5
72	137.9	124.1	103	174.5	157.0
73	139.0	125.0	104	175.7	158.1
74	140.2	126.1	105	176.8	159.1
75	141.6	127.4	106	178.0	160.2
76	142.6	128.3	107	179.2	161.4
77	143.7	129.3	108	180.2	162.2
78	144.7	130.2	109	181.2	163.2
79	145.9	131.3	110	182.3	164.2
			111	183.3	165.0
80	147.2	132.5	112	184.4	166.0
81	147.9	133.4	113	185.8	167.3
82	149.1	134.2	114	186.8	168.1
83	150.3	135.2	115	188.3	169.5
84	151.5	136.4	116	189.8	171.0
85	152.9	137.6	117	191.0	171.9
86	153.7	138.4	118	192.4	173.1
87	154.8	139.4	119	193.7	174.3
88	156.0	140.5	120	195.6	176.1
89	156.8	141.2	130	210.9	189.8

between bodies depends on the temperature, nature, and relative positions of the bodies. The hypothetical body, the surface of which would absorb all of the radiation incident upon it, is called a perfect absorber or a black body. Hence, according to Kirchhoff's law, it would also be a perfect emitter. This is the theoretical body depicted in Fig. 2. There is no existing surface which emits as much radiant energy as a perfect radiator or black body.

Emissivity e may be defined as the ratio of the rate at which a given surface emits or absorbs radiation to the rate at which a black body at the same temperature would emit or absorb radiation. Or, it may be thought of as its efficiency in its ability to emit or absorb radiation. The e of most surfaces is not constant but increases with increase in temperature. Values of e for some of the common building materials are given in Table 1. According to the Stefan-Boltzmann law, the total rate at which any body at any temperature emits radiation of all wave lengths is represented by the area under the intensity-wave length curve times the emissivity of the body.

If two surfaces are separated by some non-absorbing medium, the net rate at which surface 1 will lose heat by radiation to surface 2 is equal to the rate at which surface 1 emits radiation, minus the rate at which it reabsorbs the fraction of the radiation that is reflected back to it by surface 2, and minus the rate at which it absorbs the radiation emitted by surface 2. If it is assumed, as it is in panel heating, that all of the radiation emitted by surface 1 falls upon surface 2 and surface 2 is large in comparison with 1 and approaches a black body, then the rate at which surface 1 reabsorbs the fraction of the radiation that is reflected back to it by surface 2 is zero. Therefore, the net rate at which surface 1 loses heat by radiation is:

$$q_r = 0.173 \times 10^{-8} \; A_1 \; F_a F_e \; (T_1^4 - T_2^4)$$

where

q_r = total heat transmission by radiation, Btu per hr,

0.173×10^{-8} = Stefan-Boltzmann radiation constant, Btu per (hr) (sq ft) (degree Fahrenheit absolute temperature)^4,

F_a = shape factor, dimensionless (equal to unity in panel heating),

F_e = emissivity factor, dimensionless,

A_1 = area of surface 1, square feet,

T_1 = absolute temperature of surface 1 (panel surface temperature + 460), degrees Fahrenheit.

T_2 = absolute temperature of surface 2 (mean radiant temperature or average surface temperature of unheated surfaces + 460), degrees Fahrenheit.

The shape factor (angle factor, configuration factor) F_a, accounts for the shape and relative position of the two surfaces. It is a measure of the amount of radiation emitted by surface 1 which actually impinges on surface 2. In panel heating, all of the radiation emitted by the panel is assumed to be intercepted by the surrounding room surfaces and therefore $F_a = 1$.

The emissivity factor, F_e, accounts for the emission, reflection and absorption characteristics of the two surfaces involved, as follows:

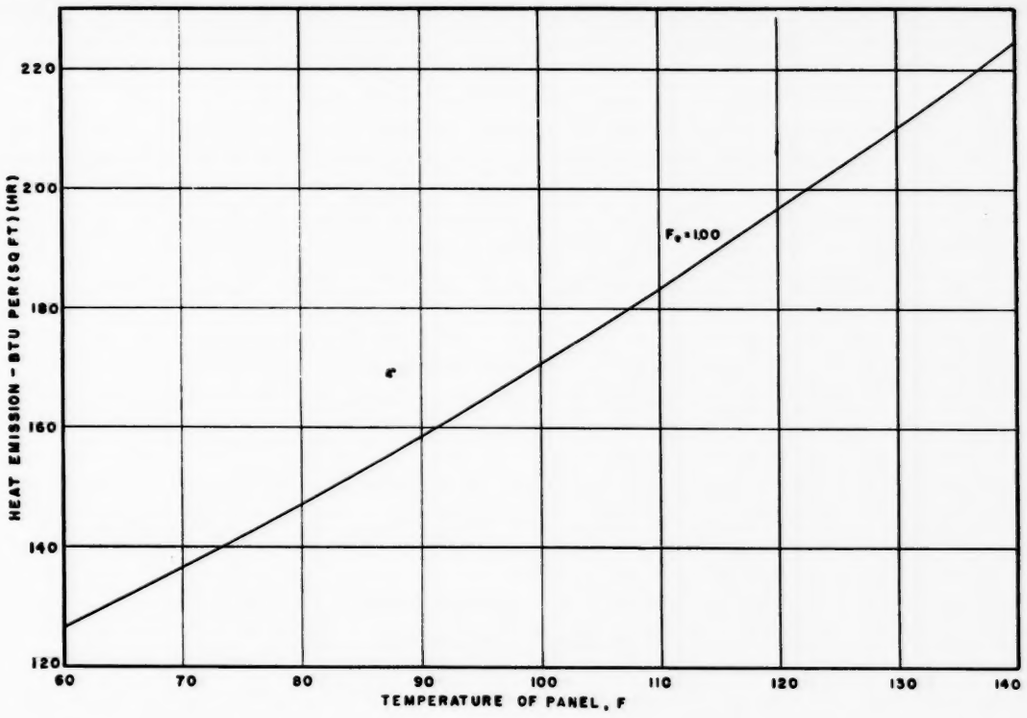
(1) For a small body in a large complete enclosure, use the emissivity of the small body only: $F_e = e_1$.

(2) For a large body in a complete enclosure, use the emissivities of both bodies:

$$F_e = \frac{1}{\frac{1}{e_1} + \frac{1}{e_2} - 1}$$

An average emissivity value to be used in panel heating is somewhere in between the above two cases. The panel is neither a very small enclosed body nor is it a very large enclosed body. It is true, therefore, that e_1 is larger than F_e which is larger than $\frac{1}{\frac{1}{e_1} + \frac{1}{e_2} - 1}$. If it is assumed from Table 1 that the

Fig. 3. Heat transfer by radiation to bodies at absolute zero.



emissivity of all common building and finishing materials is equal to 0.93, then 0.93 is larger than F_e which is larger than $\dfrac{1}{\dfrac{1}{0.93}+\dfrac{1}{0.93}-1}$ (which is equal to 0.87). Since F_e is somewhere in between, it is assumed that $F_e = 0.90$.

The mean radiant temperature *MRT* of the unheated surfaces referred to is the imaginary, uniform surface temperature of a large enclosure with which the panel would exchange the same amount of energy by radiation as in the actual room which has a nonuniformly heated inside surface. Numerical evaluation of this theoretical *MRT* is very difficult for an actual enclosure since there are many factors other than surface temperature which are found to affect it. If it is assumed that the room is large and that the surfaces are made of materials having emissivities of 0.90 and above, the radiant energy exchange may be considered approximately the same as if all of the surfaces were black bodies. The *MRT* referred to a floor, wall or ceiling panel is then a function of the various shape factors involved and is therefore meaningless unless the reference is to a specific point or place in a room, since the shape factors change as the position of the body or surface changes. If it is assumed that all infinitesimal areas have the same shape factor with respect to the panel and that the shape factors of finite surfaces are proportional to their areas, then an approximate value of the *MRT* can be obtained. In order to avoid confusion between the theoretical *MRT* and the approximate *MRT*, the term average surface temperature (*AST*) of the unheated surfaces has been used and is defined as follows:

$$AST = \frac{A_1t_1 + A_2t_2 + A_3t_3 + \text{---}}{A_{total}}$$

This is the equation generally used in domestic panel heating due to its simplicity.

The radiation equation computed for F_e values of 0.90 and 1.00 and for temperatures between 60 and 130F radiating to surroundings at absolute zero is given in Table 2. Fig. 3 is a curve derived from Table 2 for $F_e = 1.00$ only. In using Fig. 3 to calculate the heat transfer by radiation from a surface at temperature t_1 to a cooler surface at temperature t_2, the value obtained from the curve for temperature t_2 is subtracted from that corresponding to temperature t_1, and the result is multiplied by the emissivity factor F_e. These calculations have been performed in Fig. 4 for an average emissivity factor of 0.90 and for values of the AST (or t_2) between 60 and 70F.

For example, if the panel temperature is 120F, then q_r from Fig. 3 is 196.3 Btu per (sq ft) (hr). If the *AST* of the unheated surfaces is 65F, then q_r from Fig. 3 is 131.0 Btu per (sq ft) (hr). The difference is 65.3, and if the emissivity of the panel is 0.90 then the total heat transfer between the panel and its surroundings is $0.90 \times 65.3 = 58.8$ Btu per (sq ft) (hr). This value can be read directly from Fig. 4.

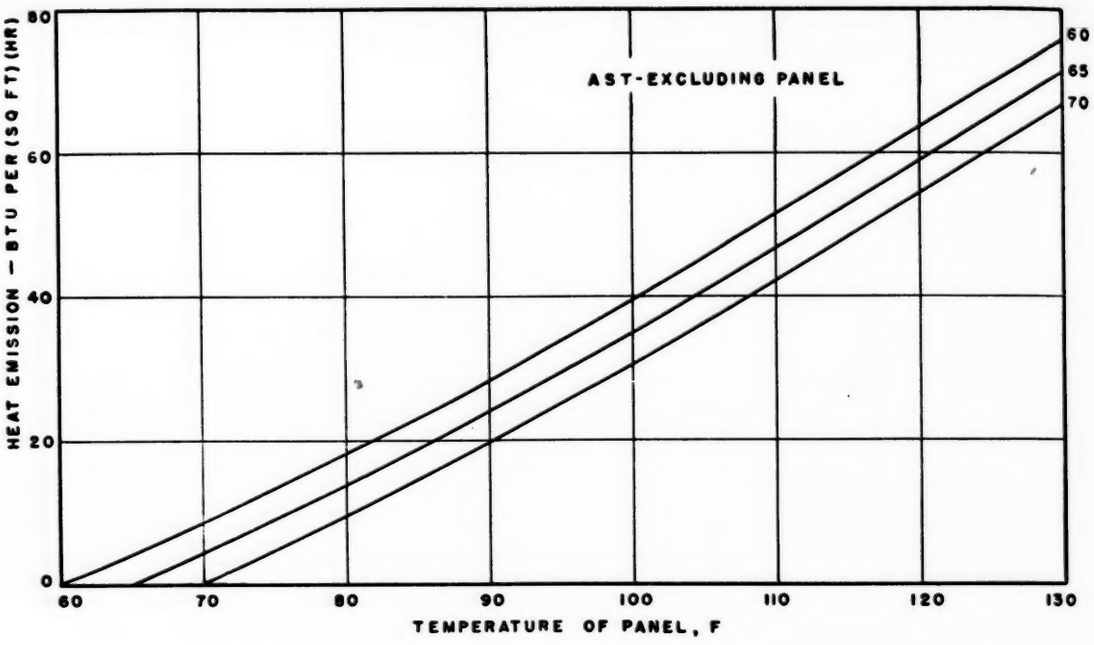
Total Heat Transfer

Fig. 4 gives the heat transfer by radiation from a panel to the surroundings in a room. For practical purposes, however, it is the total heat transfer from a panel that is of interest and this is a combination of radiation and convection. The convection heat transfer for still-air conditions has been discussed in a previous article* and as was indicated, is very difficult to predetermine for any one particular condition of operation. It depends upon air velocity and temperature and also upon the relative position of the panel—that is, floor, wall or ceiling. Fig. 5 is the total heat transfer from a panel in various positions, according to its temperature, and represents a summary of

*Carroll, Jr., J. R., Natural Convection in Panel Heating, HEATING AND VENTILATING, January, 1948.

the radiation and convection heat transfer from these two articles.

Natural convection heat transfer has the largest value for a floor panel, and since the radiation heat transfer does not depend upon the position of the panel, the total heat transfer from a floor is larger than that from a ceiling, both operating at the same temperature. A ceiling panel, however, can usually be operated at a higher temperature than a floor panel and hence, from Fig. 5, gives the greater heat transfer rate under operating conditions. It should be kept in mind, however, that the theoretical values used for the convection heat transfer in preparing these curves are probably lower than those found in actual installations. This is due to the fact that still air conditions have been assumed and in actual operation there is always a variable air motion present which will increase the heat transfer rate. However, Fig. 5 is on the safe side and until more reliable operational data are available it is suggested that these curves be used.



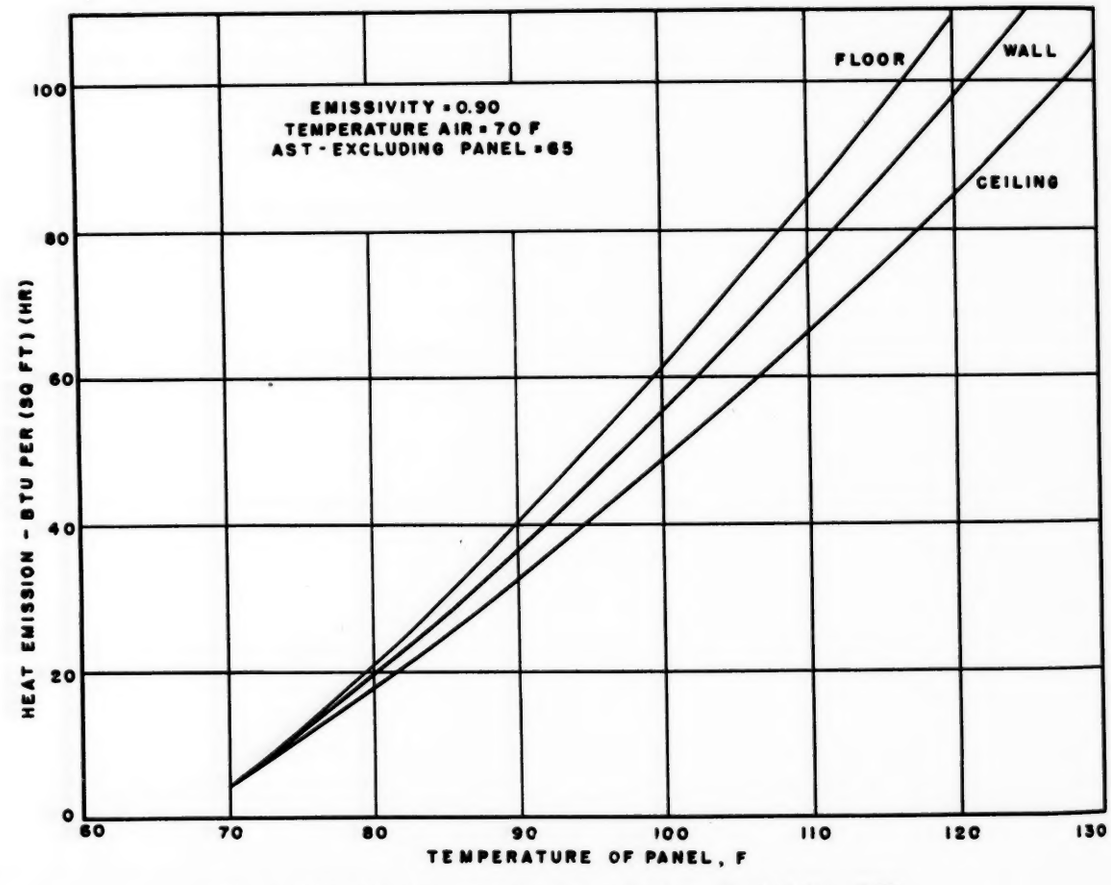


Fig. 4. (Upper) Heat transfer by radiation. Emissiviity 0.90.
Fig. 5. (Lower) Total heat transfer by panel.

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Acknowledgment

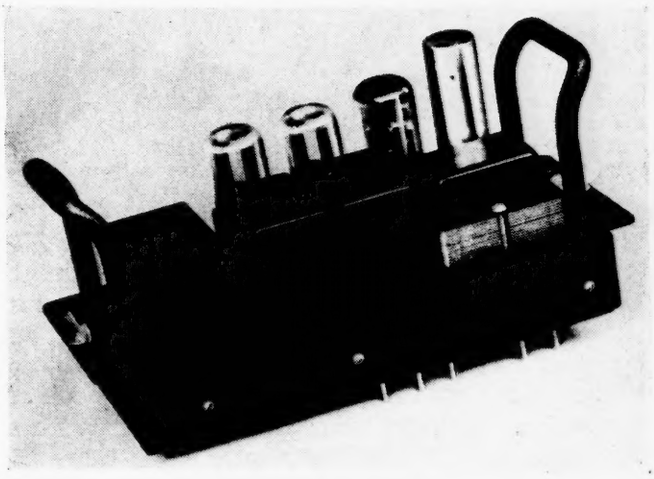
Acknowledgment is made to S. Konzo, Professor of Mechanical Engineering, University of Illinois, for his invaluable criticisms and suggestions in the preparation of this article.

Electronic Controls for Air Conditioning Systems

Air conditioning systems can now be controlled by electronic circuits considerably more sensitive than conventional controls. Details of system and units described.

AN electronically-operated air conditioning control system free from moving parts in its thermostats, and said to be a hundred times more sensitive than existing controls, is now in production by the Minneapolis-Honeywell Regulator Co. The system was developed as the result of six years research and is based on the same electronic circuits designed by the manufacturer and now in use for some years as air conditioning controls for railway passenger cars and the autopilot for four-engine bombers. Installation of this type control is recommended by the manufacturer for both comfort and industrial process applications because of its sensitivity, flexibility and simplicity.

Basic units of the new control include the room thermostat, an electronic modulating motor, duct and immersion thermostats, and an electronic relay. Additional thermostats and motors may be added to the control system in accordance with the size of the area under control.



Electronic relay, which uses standard radio tubes, takes signals from the thermostats and amplifies them to a current to operate control motors.

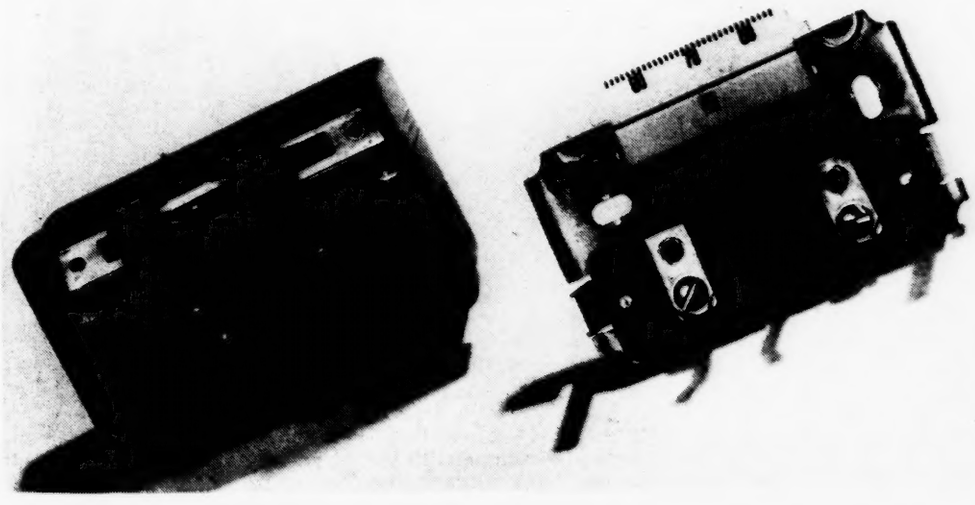
Thermostat

A single thermostat can be used for both heating and cooling, with automatic change-over from one to the other at any selected temperature level. Compensators may be added to change inside temperatures in accordance with outdoor temperatures. In the case of summer cooling, inside temperatures may rise along a pre-selected scale in proportion to the rise in outdoor temperatures; in the case of heating, inside temperature may rise as the outdoor temperature falls, also in accordance with a pre-selected scale. While this feature has been rather complex with conventional controls, it can be achieved simply by electronic means.

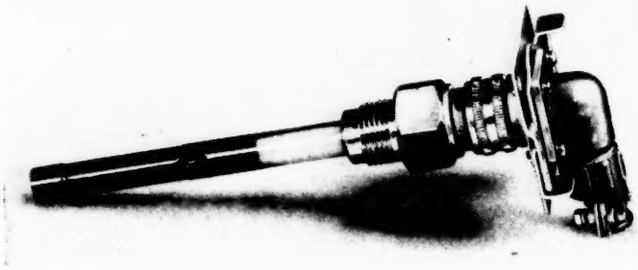
The temperature-sensing device, although small and exceedingly simple, deserves some attention. Since the sensitivity of a control is dependent on its mass, sensitivity may be increased if the mass of the temperature-sensing element is reduced and means provided for amplification of the impulse generated by the temperature change. For amplification, the radio or electronic type of vacuum tube is used.

Electronic thermostats can be made with a response a thousand times as fast as with conventional controls. For that reason it was necessary to desensitize the control somewhat by adding mass to the temperature-sensing element so that it would not react to momentary and incidental reactions, such as persons walking near the thermostat.

There are no moving parts in the thermostat. Ac-



Interior view of the electronic thermostat. Inside cover, left, includes a coil of wire to measure temperature changes. Temperature scale permits device to be set from within to prevent tampering. Pointer extends above the case and slides along scale on mounting bracket, right.



Duct thermostat consists primarily of a coil of wire wound around the tube illustrated. Unit is also used as an outside compensator to measure outdoor weather and to make compensating adjustments to temperature setting of the control system.

tually, the temperature-sensing component consists of 11 loops of wire wound on a plastic frame 1½ x 2 in. The temperature-sensing element is used for any range of temperature, from a sub-zero to 120F or higher. Since the electrical resistance of the coil varies with a change in temperature, it is connected to an electronic relay which can interpret a change in temperature of several hundredths of a degree. Minute impulses from the thermostat coil are amplified by electronic vacuum tubes so that an electric current is made available powerful enough to operate the motors which position valves and dampers in the system under control.

The thermostat is held into its mounting bracket by clips to facilitate quick removal. Temperature selection scales are mounted, one on the inside and one on the outside of the cover. Where the thermostat is in a factory or commercial building, the external scale may be removed to prevent tampering with the control setting.

Motor

The electronic motor used is similar to the company's standard air conditioning control motor except that it includes an electronic potentiometer wired in balance with the thermostat coil, no mechanical amplifying relay being needed. The motor, which is in constant balance with the thermostat through the electronic bridge circuit of the system, is connected directly to dampers in the air conditioning ducts, or to valves in the case of hot water or steam heating installations.

Immersion Thermostats

Duct and immersion thermostats, also part of the bridge circuit, maintain selected water or air temperatures at all times so that adequate supply will be available when called for by the space thermostats. The duct and immersion units, like the room thermostats, consist primarily of fine electric wire through which a small current is passed to measure resistance change caused by a rise or fall in temperature.

Service

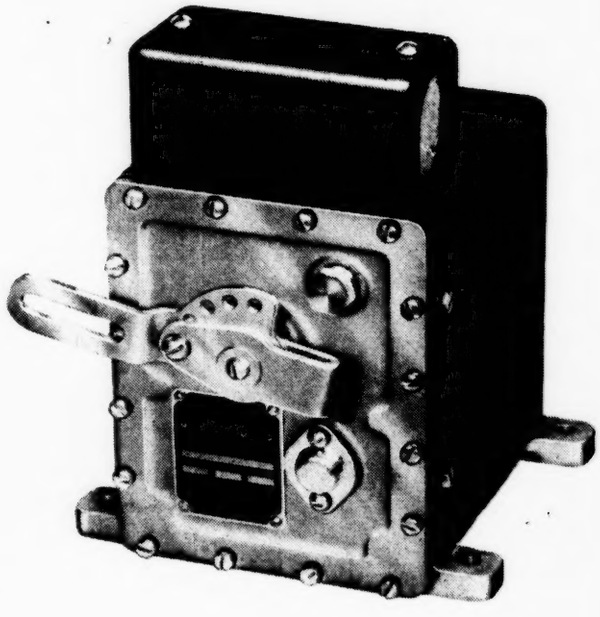
The entire system can be serviced by building or plant engineers, although the only servicing that is anticipated is the changing of tubes. As the tubes are operated at a fraction of their normal rating, the life of the tubes is greatly increased and is expected to be several years. Electronic circuits and relays have been on test on railroad cars for two years and to date neither tubes nor any of the units in operation have been replaced. The amplifier may be easily removed in a few minutes for servicing or for replacement with another unit.

Cost

For the average heating, ventilating or air conditioning system, it is expected that the cost of the electronic control will be from 25% to 35% greater than the cost of an equivalent electrical control system, but the important advantages justify this increased cost in a large number of cases. There are, however, certain applications where its cost might not be warranted. For example, with the present cost of this equipment as compared to pneumatic equipment for individual radiator control used in the company's personalized heating control for apartments, the pneumatic units should be used.

Summary

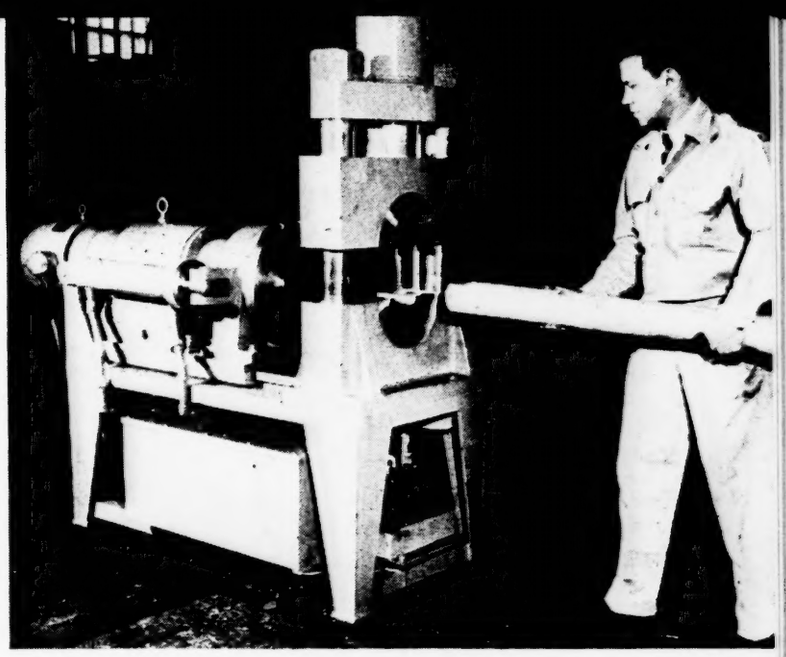
Stability of control for both comfort and process applications depends upon the speed with which the controlling devices can sense a change. The impulse from a minute change must be amplified and the vacuum tube is the most efficient amplifier known. Consequently, in view of this and the fact that electronics makes it possible to overcome such problems as the variable relationship between inside and outside temperatures, the introduction of this system becomes an outstanding development.



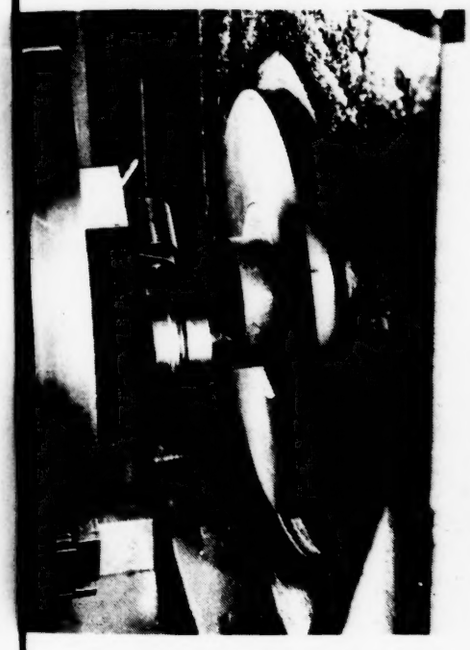
Electronic modulating motor includes a potentiometer wired in balance with the thermostats of the system. Motor positions damper or valves.

New Joint for Stainless Steel Pipe

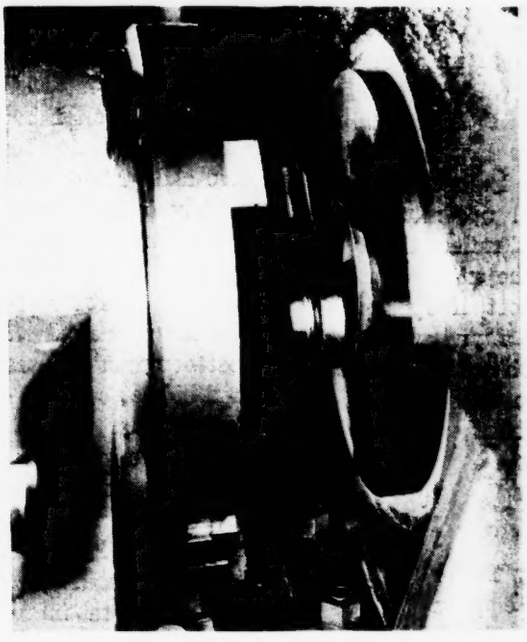
Light wall stainless steel pipe can be cold-Vanstoned in the field by a portable machine developed by The H. K. Ferguson Co., Cleveland, Ohio. This hydraulic machine weighs about one ton and is adaptable to any size stainless steel pipe. Rollers flare back the pipe ends. Split-type back-up flanges are used to hold together the flared ends. Arrangements have been made for the production of these split steel fittings in 125 lb pattern so that the only step necessary is to cold-Vanstone the pipe ends in the field. With this type of joint, the pipe line can be assembled by bolting together the split fittings back of the flared ends, and it can be demounted at will.



Inserting the pipe in the hydraulic machine, the first step in making the flared end.



The conical roller makes contact with the pipe end and begins to travel a circular path around the inside pipe wall.



When the pipe end has been flared out to the form shown, the work of the conical roller is completed. This roller is removed to make way for a cylindrical roller.

A cylindrical roller goes into play to flatten the flare against the plate to complete the forming.

Left to right, W. S. Robinson, president, Robinson Engineering Co., Roselle Park, N. J., and J. Harry Frankfort, The H. K. Ferguson Co., project engineer who develcped the process. At the left is the length of stainless steel pipe that has been cold-Vanstoned and on top of this pipe is one half of the split-type back-up flange which when bolted to a similar flange on the L-fitting which is being examined, will form a complete joint.

Shielding Fan Systems from Corrosion

WALTER E. LANGLOIS
Industrial Department, Sturtevant Division,
Westinghouse Electric Corp., Hyde Park, Mass.

A discussion of protective coatings to safeguard fan systems from corrosive and abrasive action of the fumes and air moved. Tables show specific coatings that will resist the action of acids and salts.

EXPANSION of the mechanical and chemical industries over the last half century has been phenomenal. As each new process has been developed, problems have presented themselves related to handling of the product, by-products, or air that has been utilized or contaminated in processing. One of the most logical methods of meeting this problem is the fan or blower system.

When the earliest blower systems were installed, no thought was given to possible chemical or abrasive action ruining fans, ducts or collectors. In more recent years, and especially within the last 10 or 15 years, this action has assumed major importance. As manufacturing processes are speeded up, more and more active agents are introduced, and unless the system is properly protected, the life of the entire system can be so shortened as to make the cost of operation prohibitive. Moreover, a leak occurring anywhere along the system could create a serious health or fire hazard. The savings that are introduced, both in dollars and man hours, by properly protected systems, more than justify the increased initial cost.

Methods of Protection

In general, systems are protected by the use of one of the following: special metals in the equipment, special paints, metal coatings, resin based and plastic coatings, and rubber coatings, both natural and neoprene. Since each of these has advantages and disadvantages when exposed to various fume conditions, the merits of each must be carefully considered when a selection is to be made.

The reaction of gases upon metals, and especially moist gases, is extremely severe. Most manufacturers of protective materials have run exhaustive tests on specimens of their products immersed in acid solutions. These tests, while interesting, prove nothing conclusive when moist acid gases are encountered. The rotative action of a fan rotor tends to hurl minute particles of the acid with terrific force at the fan casing and the velocity of the conveying air continues the hurling of these particles throughout the duct. Any part of the fan or ductwork not properly protected immediately becomes a point at which corrosion can set in. The same is true of abrasive materials being conveyed by air. Excessive wear will set in at any point in the system not properly protected. It also holds for material collectors. In the case of acids, two factors must be carried in mind when making a selection:

(1) Concentration of acids in the gases.
(2) Temperature of the gases.

Both of these factors have an extremely important bearing on the life of the system and warrant the utmost consideration.

A few years ago, the trend of most thinking was that if special conditions had to be met, fans and ducts of special metals such as stainless steel, aluminum, Monel, or brass had to be furnished. Many industrialists today still adhere to this school of thought and admittedly obtain excellent results from the systems, although obviously a system so constructed is extremely expensive. Not only is the cost of materials greater, but in fabrication, special practices must be developed to suit the special metals. Often the metals have a degree of hardness that makes fabrication extremely difficult and costly, yet the permanence of a system so constructed easily justifies the initial cost.

In an attempt to reduce the cost of blowers for handling corrosive fumes, several types of metal linings have been used more or less successfully. The most common illustration of this is perhaps, the lead lined blower often used to handle SO_2 fumes. The lead lining, when properly built into the fan, provides a surface every bit as good as if the entire blower were built of the same material. The best job of this type, obviously, is when sheet linings are applied and the joints carefully sealed with the same material. One bad feature exists, however, in that the weight of the rotor is often increased to such an extent that a heavier shaft and bearings are required, thereby increasing the cost.

This increase in weight, together with the difficulties in fan design that naturally would exist due to sheet coating, brought on the next development—the spraying of special metals on the fan surfaces. Sprayed

Table 1—Recommended Maximum Temperatures for Fumes

Fumes	Concentration %	Max. Temp. F
Sulfurous	100	212
Sulfuric	25	176
Hydrochloric	20	176
Chromic	5	140
Nitric	5	86
Acetic	100	212
Formic	100	212
Oils, fats, waxes	100	392

on coatings and galvanizing can be applied to any desired thickness and so the load carried by the fan shafts can be controlled. For mild acid conditions, sprayed on coatings will be found satisfactory, but obviously there is a definite possibility that remote parts will not be as heavily coated as the more accessible. Such coatings quite frequently are apt to be porous and therefore should not be used where conditions are severe.

Problems presented by the use of special metals, especially the cost, have caused the trade to approach the handling of gases from another angle. In recent years a definite trend has existed toward using standard steel and cast iron parts, and painting or coating the entire system. Painting is undoubtedly the least expensive installation, as no preparation other than cleaning the surfaces to be painted is required. The biggest single objection to painting is that the paint will have to be replaced periodically. Black asphaltum has proven to be an excellent, inexpensive coating for handling mild acid conditions, provided the entire system is dismantled and all exposed surfaces repainted once or twice a year.

When any coating is used, all ductwork should be flanged. A slip joint connection will almost always create an exposed surface for the acid to attack. Another advantage exists in flanging ductwork in that if it becomes necessary to insulate the system against acting as a conductor of electricity, it may be done by placing gaskets of suitable materials at strategic flanges. When this is done, care must be taken to insulate around the bolts and nuts connecting the flanges as well as to provide the gaskets.

Other inexpensive coatings that can be applied like paint have been developed in recent years. These generally are made with either a resin or a plastic base, and can be applied at the job without requiring any special or expensive equipment. Nearly all can be applied either by brush or spray gun. The majority are reasonably resistant to a goodly number of acids and alkalis and a few are claimed to be resistant to oils. The manufacturer of one of these painted on coatings asserts that after coating the ductwork of a certain chemical plant with his product, ducts that had previously corroded through in three months were still in good condition after six years of the same type of operation.

It must be realized that coatings of this sort are limited in application. All will resist an appreciable number of acids and alkalis, but none will resist them all. Few will resist solvents of any sort. As mentioned above, the concentration and temperature of the fumes constitute important factors in determining the suitability of the coating. It is recommended that the user check carefully with the manufacturer of the coating as to its suitability before applying it.

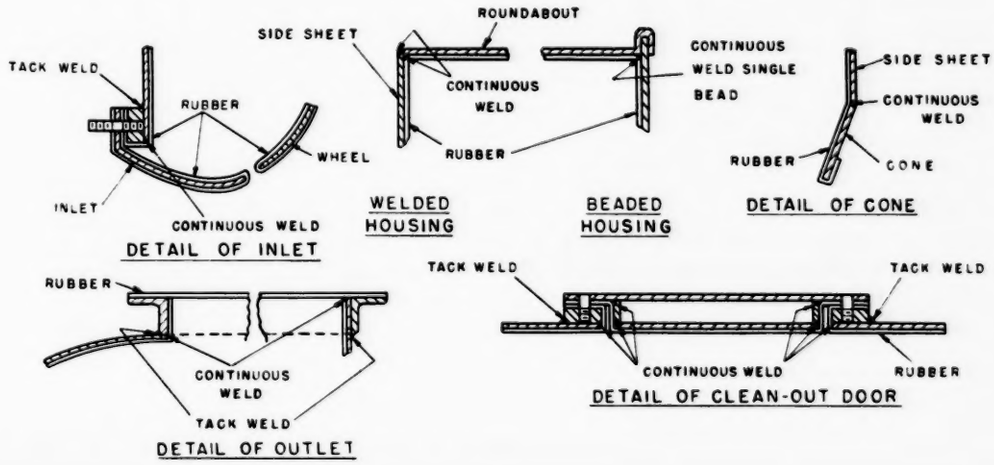
One other advantage is offered by the manufacturers of some of the painted on coatings. Several of the coatings are offered in a variety of colors, so that if different systems are handling different fumes, painting the outside of the systems with the same coating provides a convenient means of identification.

Another type of coating that has become increasingly popular in recent years is the phenolic resinoid. Normally baked on, this type of coating provides a hard surface that is excellent for repelling the action of many acids, where temperature limits are not excessive. A few of the more common acids and recommended maximum temperatures are listed in Table 1. Temperatures are for baked coatings.

Of the fumes listed in Table 1, chromic and nitric acids will have a tendency to discolor the coating. The other acids listed will not have any apparent effect. Manufacturers of this type of coating also generally produce an air dried coating that can be applied on the job. The convenience of this feature is readily appreciated, but in the opinion of the writer, the efficiency of the air dried coating will not be as great. If the parts that are subjected to the most severe action are coated with the baked on coating, often the remainder of the system can be coated at the job at a substantial savings in price.

Generally this type of coating is not recommended wherever abrasion is apt to develop. There is a definite danger of chipping or otherwise impairing the coating. If a coating is ruptured in some manner, prompt application of the air dried coating can prevent any appreciable damage from taking place.

Still another type of lining has increased in popularity in recent years. This is the vinyl resin. It has the excellent quality of being a hard but flexible lining that offers high resistance to nitric acids, bleaches and solvents. In general it may be used where strongly oxidizing fumes decompose natural or neoprene rubber and where severe temperature and abrasion prohibits the use of resins. As each successive coat of this substance must be baked on, its use is restricted to those manufacturers who possess baking facilities or the material to be lined must be shipped to the supplier of the coating.



Housing construction details of rubber coated fans.

Table 2 — Chemicals Resisted by Vinyl Resins

Chemical	Concentration %	Max. Temp. F
ACIDS		
Acetic	Up to 10	85
Boric	Any concentration	170
Carbonic	Any concentration	170
Citric	Up to 10	100
Fluoboric	Any concentration	170
Fluosilicic	Any concentration	170
Formic	Up to 10	75
Hydrochloric	Any concentration	140
Hydrofluoric	Any concentration	100
Hypochlorous	Any concentration	100
Nitric	Up to 10	160
Nitric	Any concentration	90
Oxalic	Up to 10	150
Perchloric	Up to 10	100
Sulfuric	Up to 50	180
Sulfurous	Up to 6	100
SALTS		
Alum. chloride	To saturation	100
Alum. nitrate	To saturation	170
Alum. sulfate	To saturation	170
Amm. acetate	Up to 10	100
Amm. chloride	To saturation	150
Amm. hydroxide	To saturation	85
Barium chloride	To saturation	170
Cadmium cyanide	To saturation	150
Cal. hydroxide	To saturation	170
Copper nitrate	To saturation	170
Ferr. amm. sul.	To saturation	150
Lead nitrate	To saturation	150
Mag. hydroxide	To saturation	170
Mag. sulfate	To saturation	170
Merc. chloride	Up to 10	85
Nickel sulfate	To saturation	170
Potassium & sodium bicarbonate	To saturation	170
Zinc chloride	To saturation	170
Zinc sulfate	To saturation	170

Table 2 presents a partial list of acids and salts resisted by vinyl resins.

Probably the best known of all protective coatings is rubber, both natural and neoprene. Neoprene is used for protection against almost all acids, all alkalis and many solvents up to a temperature of approximately 200F. Natural rubber can be used advantageqously to resist several acids not resisted by neoprene or vinyl resins. A suggested list of acids with concentration and temperature limitation is given in Table 3.

In general rubber coatings will resist the action of the following:

Any strength of ammonia, ammonium salts, neutral salts, alkalis, oxalic acid, oxalates, tartaric acid, tartrates, phosphoric acid, phosphates, caustic soda, and sodium carbonates.

Sodium chloride and acid salts with the exception of those that set free oxides of nitrogen, chlorine and bromine.

It will also resist the actions of acids of the following per cent strengths: Hydrochloric acid, up to 30%; sulfuric acid, up to 50%; acetic acid, up to 10%; chromic acid, up to 10%; ferrous chloride, up to 50%. In addition natural rubber affords excellent resistance to abrasion.

When using either the vinyl resin or the natural or neoprene rubber coating, considerable thought must be given to the construction of the equipment to be coated. Obviously no removable bolts or nuts can rest on the coated surfaces, as in servicing parts, removing the bolts will rupture the coating. Many coating suppliers prefer to cement on the rubber in large flat sheets and the need for flat surfaces with no protruding elements becomes even more apparent. Another factor that requires serious consideration is the clearance between parts. Where definite clearances must be kept, special construction is an absolute necessity as the rubber is normally applied $\frac{1}{8}$ in. thick and occasionally as heavy as 3/16 in. or greater. Typical construction details are shown in the sketches.

From this it can be seen that there are a great many ways that corrosion and abrasion protection in a fan system can be obtained. The actual selection of the type of protection to be used varies with the requirements both from the standpoint of the suitability of the coating, the original cost, and cost as determined over a period of years.

The protection of cyclone type collectors against abrasion can be accomplished by coating with natural rubber when coating the rest of the system with the same material. Other methods often used are to equip the collector with wearing strips or spirals or to line the inside with concrete. In one instance the writer has known of a collector equipped with a ceramic tile lining. It is recommended that any user, faced with a serious abrasion problem in a cyclone type collector, check with the manufacturer for recommended linings.

Where abrasion is the only serious factor to be contended with, it is often possible to provide heavy material traps at strategic points along the ducts and by trapping out the greater portion of the heavy particles, materially reduce the wear on all equipment beyond the trap.

The corrosion resistance tables in this article have been compiled from research data of reliable producers of protective coatings.

Table 3 — Acids Resisted by Rubber

Acids	Concentration %	Max. Service Temp. F
NATURAL RUBBER		
Hydrochloric	Any concentration	150
Hydrofluoric	Up to 10	150
Hypochlorous	Any concentration	150
SYNTHETIC RUBBER		
Arsenic	Any concentration	100
Boric	Any concentration	200
Carbonic	Any concentration	200
Citric	Up to 10	100
Fluoboric	Any concentration	100
Fluosilicic	Up to 10	100
Lactic	Any concentration	90
Maleic	Up to 10	100
Malic	Any concentration	100
Oxalic	Up to 10	200
Phosphoric	Up to 85	200
Sulfuric	Up to 20	170
Tannic	Any concentration	200
Tartaric	Any concentration	100

A Material for Industry

Insulation for Ducts

GLASS fibers form the basis of two new types of insulating material for covering ducts. These fibers will not support combustion, can not absorb water, and will dry out rapidly if wetted.

The coated or board type, mottled brown in color, is for use with cold or hot ducts to temperatures of 250F. It has a coating on both surfaces that can be painted or covered with asbestos paper or canvas. The insulation comes in units, 24 x 48 in., in four thicknesses, and has a density of 6 lb per cu ft. For the ⅝ in. thick material, the weight is 5 oz per sq ft; 1 in., 8 oz; 1½ in., 12 oz; 2 in., 1 lb.

Thermal conductivity, k, is 0.265 at a 75F mean temperature.

This board can be cut with a knife to the size and shape of the duct. However, when sized it should be its own thickness wider than the duct on the upper and lower sides of horizontal ducts, and on opposite sides of vertical ducts to provide supports for the other boards required to complete the covering, and also for the corner insulation. To permit a tight fit against curved surfaces, the board insulation can be scored with a knife for about one half the insulation thickness by making parallel marks at 1 in. intervals for sharp bends and cuts at 2 in. intervals for gradual bends. This scoring, which should be at right angles to the curvature radius, should cover the full area of the bend.

There are two methods of applying this board to the duct such as by using metal clips and adhesives and by use of wire and metal edges.

All edges and seams of the insulating cover should be covered with 3 in. wide Fiberglas industrial tape.

After the insulation is in place and all open joints filled, a vapor seal can be applied consisting of light-weight muslin or asbestos paper pasted to the surface and finished with one coat of size and two coats of an aluminum or vapor-impervious asphalt paint. Where the surface is to be painted, a casein-base water paint may be used, or it may be painted with varnish-base paints, or asphalt base aluminum paint. Because of the nature of the coating, an oil-base paint should never be used. Asbestos paper or canvas may be pasted on the entire surface of the insulation, and painted if desired.

Flexible type of duct insulation can be applied with an adhesive to a metal duct. Joints in the insulation are covered with adhesive tape.

Coated duct insulation can be cut with a knife to the size and shape of the duct.

The flexible duct insulation, also made of glass fibers, is made in 54 in. width rolls. The ½ in. thick material comes in rolls 50 ft long; the insulation 1 in. thick in 25 ft rolls. Both thicknesses come in two densities—0.5 lb per cu ft or 0.021 lb per sq ft, and 1.0 lb per cu ft or 0.042 lb per sq ft. The conductivity or k factor is 0.26 for the 0.5 lb density and 0.23 for the 1 lb density for a 75F mean temperature.

This insulation which is made from glass fibers lightly bonded with a thermosetting resin, and is uncoated, is designed for concealed duct applications where finish is not necessary. It can be used for all types of high and low temperature applications. The insulation can be applied to any metal duct by painting stripes of special commercial adhesives around the duct before applying the insulation. A Fiberglas industrial tape is used to cover the seams.

These insulations are made by Owens-Corning Fiberglas Corp.

How to Insulate Concrete Floors

The following suggestions are based on a report by Laurence Shuman, mechanical engineering adviser to the technical staff of the Housing and Home Finance Agency. Mr. Shuman cites the work of the National Bureau of Standards on heat losses from slab floors and presents drawings of various recommended methods of insulation.

THE primary heat loss of concrete slab floors, laid either on the ground or over crawl spaces, is through the edges. This is the result of (a) the natural insulation provided by the mass of earth under a slab laid on the ground and (b) the tendency of enclosed crawl space temperatures to be higher than outside air temperatures. Surface temperatures toward the centers of floors over crawl spaces are generally lower than those of ground-laid floors.

Insulating the concrete floor slab at the edges reduces heat loss to the outside. When so insulated, a concrete floor may have a higher surface temperature near the edge than ordinary floors because of rapid conductance from the warm center portion.

For comfort, floor temperatures should not fall below 60F one foot from the outside wall when the inside air temperature is 70F. This condition may be accomplished by insulation of slab edges and, where the floor is over a crawl space, insulation of the exposed wall of the crawl space.

Table 1 shows five suggested insulating materials and their characteristics. The *R* factor shown in this table is a heat resistance based on —20F outside design temperature and is used to estimate the required thickness of the chosen insulation installed in accordance with Fig. 1 to 6. Variations of *R* for different design conditions are shown in Table 2. Since resistance varies in proportion to the thickness of a homogeneous material, values of *R* shown in the drawings may be multiplied by the indicated percentage factor to determine the thickness required under a given set of conditions.

The insulation shown in Fig. 1 to 6 is based on minimum desirable results for a heating design temperature of —20F. Resistance values *R* are given, rather than the specific thickness of the insulation. Modifications in the extent of the insulation for design temperature of 0F are also indicated. If floor heating is used, 50% more insulation is desirable for greater fuel economy, as shown in Table 2.

Where foundations are not carried below frost line, it is better to permit inside heat to travel down to the bottom of the footing, as shown in Fig. 4B and 4C. This is in contrast to the method shown in Fig. 4A, which method should be used only where the footing actually extends below the frost line.

Some drawings (Fig. 1A, 1C, etc.) show roofing felt extending under the entire concrete slab and up to the edge of it. Roofing felt, where used, should be not less than 30-lb asphalt- or coal-tar-pitch-impregnated felt.

Table 1 — Insulating Materials for Slab Floors

(1) Cellular glass enclosing sealed-in gas, such as Foamglas.

Thickness:	2 to 5 in.
R Factor:	(per inch thick) 1.82 to 2.22
Characteristics:	Crushing strength approximately 150 lb per sq in. Water absorption negligible. Easily cut, indented, etc. Will not adhere to masonry.
Suggestions:	Surface may gradually spall away if subjected to moisture and freezing. Dip in roofing pitch or asphalt for protection. Use tie wires for attaching to masonry.

(2) Glass fibers with plastic binder, such as Fiberglas, coated or uncoated.

Thickness:	.75 to 2 in.
R Factor:	(per inch thick) 3.33 to 3.85
Characteristics:	Will support about 12 lb per sq in. Water penetration into uncoated board is slow and disintegrates the binder. Water penetration into coated board is inconsequential unless exposed to a constant head of water.
Suggestions:	Use coated board or apply coat to uncoated board, using coal tar pitch or asphalt. Where moisture is expected, coat all cut edges. Follow manufacturer's instructions for cutting.

(3) Cane or wood fiber boards, such as Celotex.

Thickness:	.5 to 1 in.
R Factor:	(per inch thick) 2.50 to 2.86
Characteristics:	Crushing strength is adequate. Boards are subject to moisture penetration. Deteriorates under damp conditions.
Suggestions:	Coat boards and all cut edges heavily with coal tar pitch. Do not use in locations subject to considerable moisture.

(4) Hard cellular rubber enclosing sealed-in gas, such as Hard Rubber Board or Rubatex.

Thickness:	.5 to 2 in.
R Factor:	(per inch thick) 4.00 to 5.00
Characteristics:	Crushing strength approximately 70 lb per sq in. Water absorption negligible. Easily cut, indented, etc. Does not adhere adequately to masonry.
Suggestions:	Split board with leather splitting machinery to reduce costs. Coat with asphalt or pitch, or use metal ties or cement keys where necessary to bond to masonry.

Table 2 — Suggested Variations in Insulation, Based on Drawings

Heating Design Temp., F	Relative Percent of Values of R	
	No Floor Heating	Floor Heating
—20	100	150
0	75	113
+20	50	75

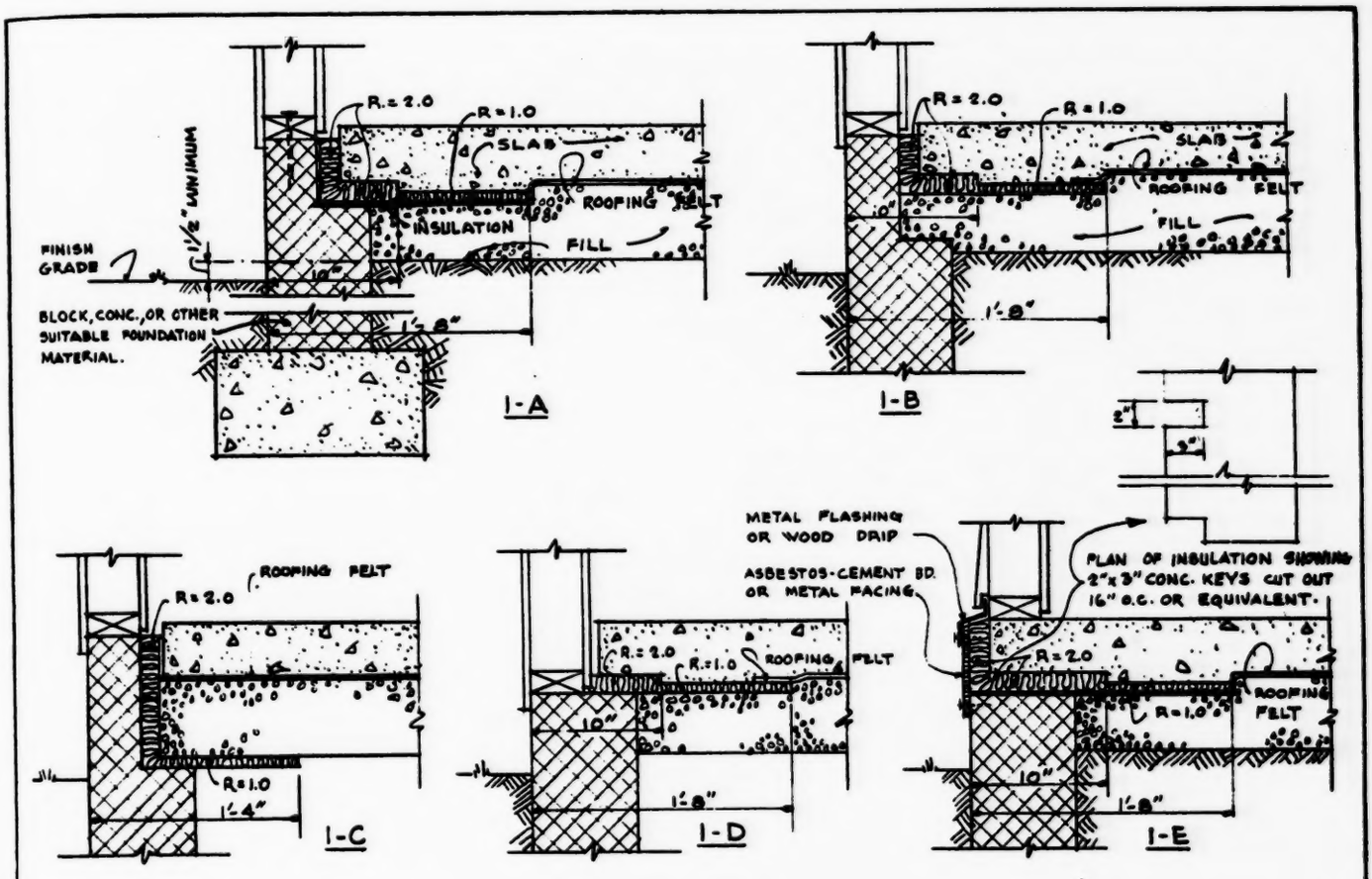


Fig. 1. Concrete slab on ground.

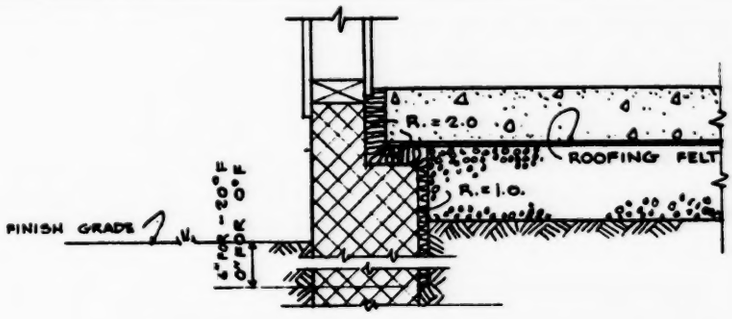


Fig. 2. Insulation at inside of foundation wall.

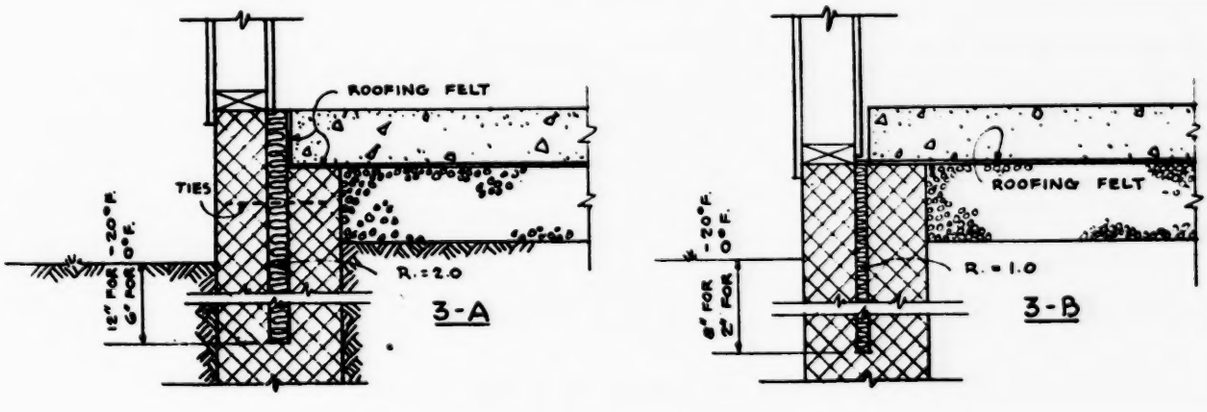


Fig. 3. Insulation at center of foundation wall.

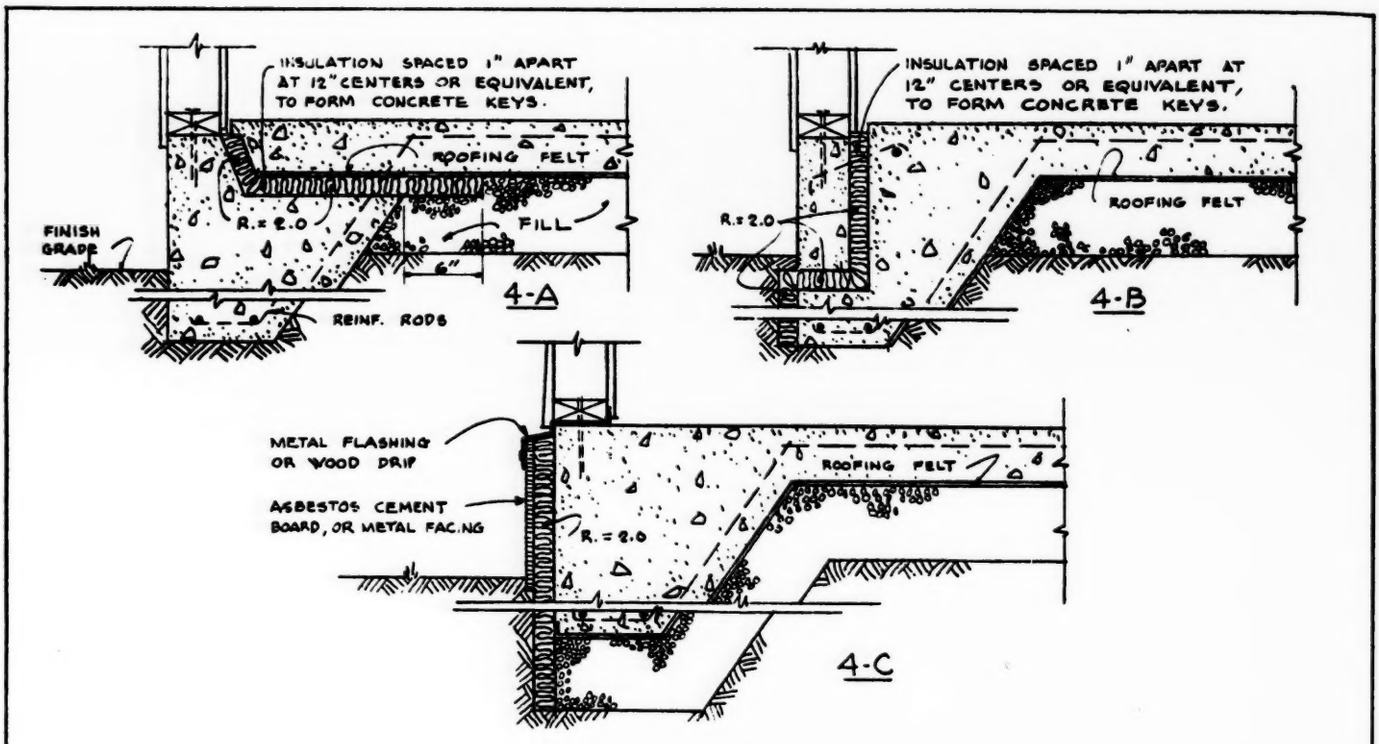


Fig. 4. Floating slab foundations.

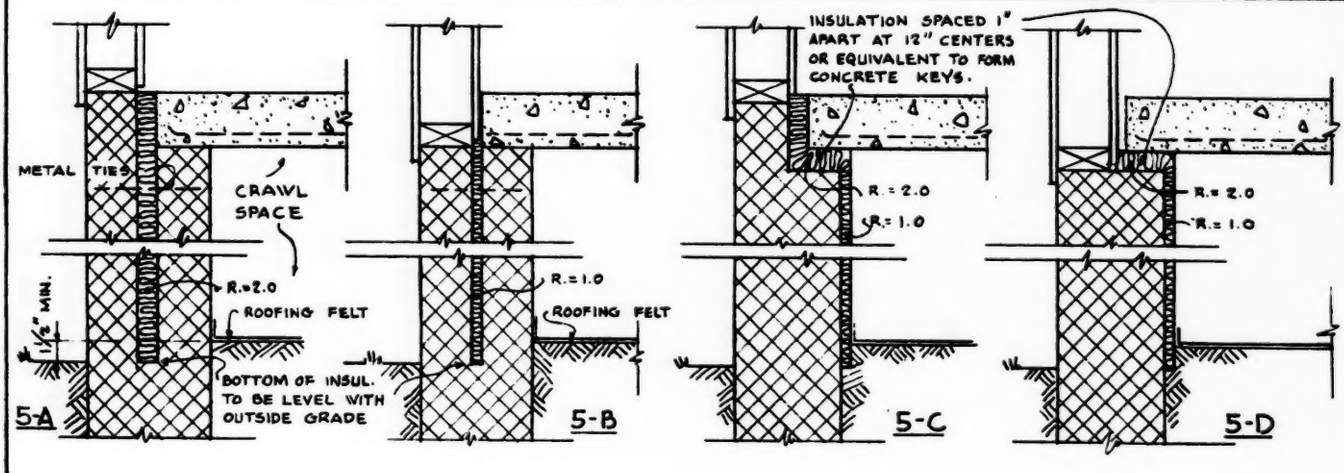


Fig. 5. Concrete slab over crawl space.

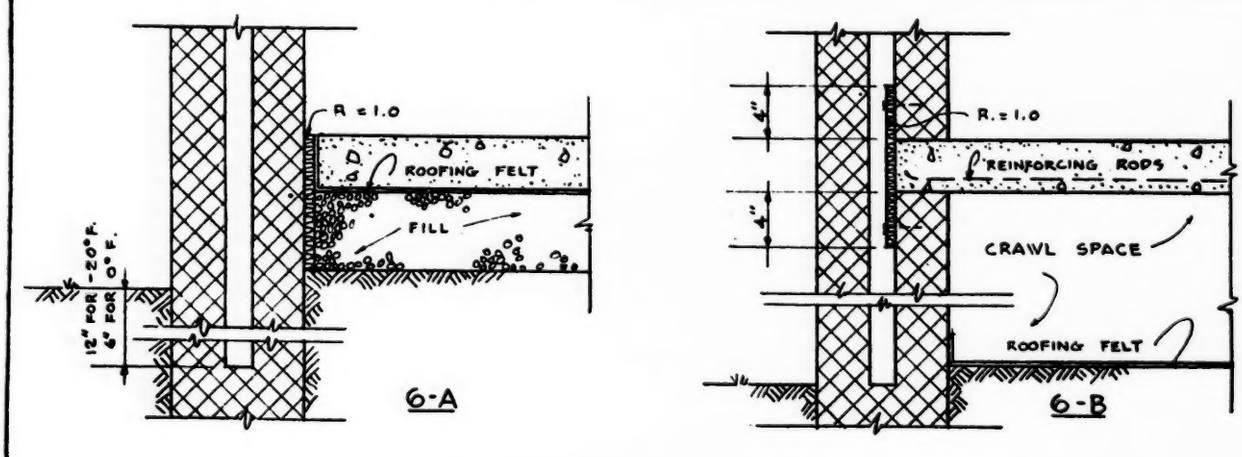


Fig. 6. Cavity walls.

Experience is my Classroom

By T. W. REYNOLDS

UNCOMMON SENSE

Horace Greeley said, "Go west, young man," but he did not say that in doing so you will run into a lot of codes built up to protect the small job against shysters. These codes are voluminous, cover everything and unnecessarily restrict the large job with the best of engineering talent behind it. Such codes may or may not be constitutional for they even tell you what velocities can be used in the ducts and otherwise design your job.

If one is building a large boiler plant and there will be 24-hour attendance when in operation, then of what use is a low water cut-off on the boilers as required by one western code. The plant is full of other controls more vitally needed while a low water cut-off is sometimes required in a residential heating plant. In residential plants there is attendance only once a week or say a day at the most.

Safety controls, when in excess, are a waste of money and are seldom used after awhile. If a horn blows (is always warning) it annoys the engineer, and he shuts it off. So common sense is needed in these codes for one can get too close to a subject and become too theoretical. When is the restrictive measure a too costly form of insurance as coverage for remote liabilities? Where do we draw the line? If we want to be really safe, why build a boiler plant at all? It is always a risk to build and to operate.

CHANGING TIMES

Walking by the demolition of the old Murray Hill Hotel in New York City, I paused to look down where the old power plant is still left, for they generated their own power for many years. Doubtless by now the plant has paid for itself, and this, most likely, was one of the arguments once advanced for its going in. I could hear another voice counter arguing, "But you are not in the power business. You are running a hotel."

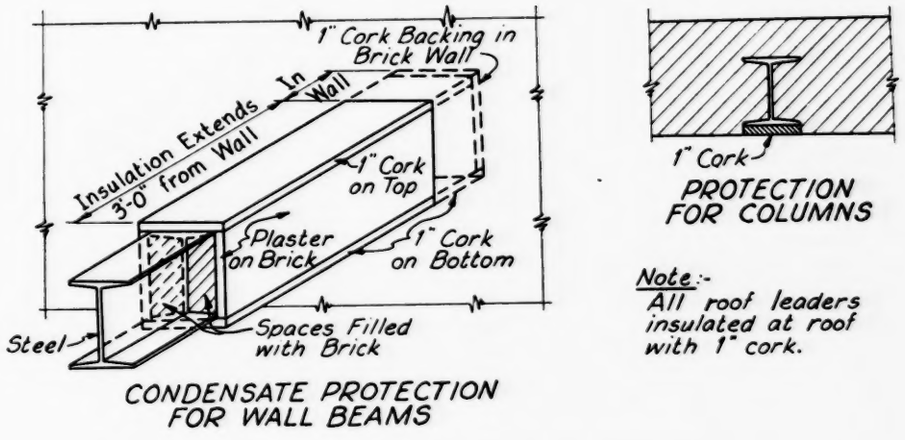
Just then the boss wrecker interrupted my historical reveries by ordering me on my way. These fellows have a tough job and they are tough and he did not want me killed because it takes time and turns out to be expensive. I moved away before I realized that I had as much right to that sidewalk as he did.

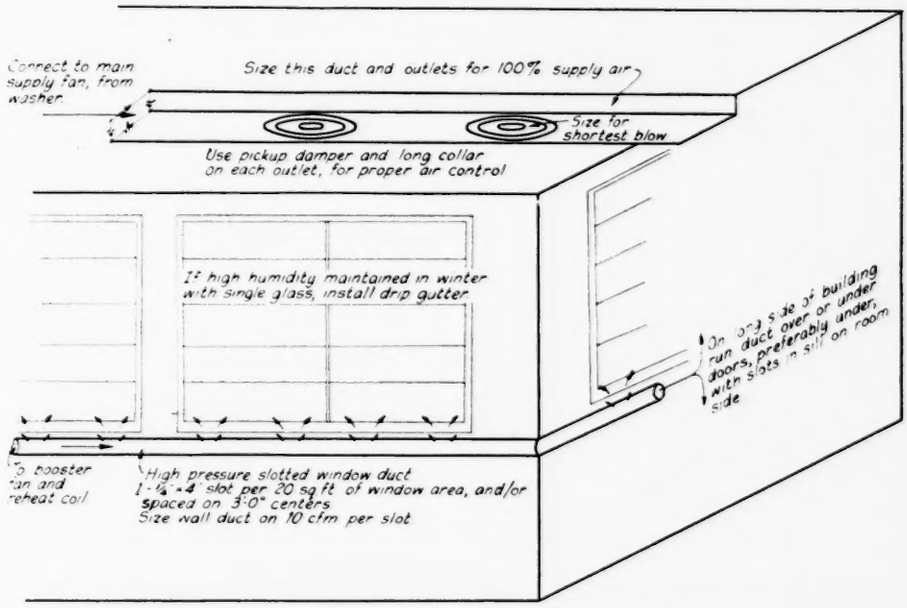
A New Yorker always feels that way, that he should enjoy the right to be killed if he wants to. What interested me as I wandered on was that many years back no one cared or ordered you on because human life was then of less value and the reponsibilities of a wrecker to the public were not so great.

HOW TO CARE FOR CONDENSATION.

From the writer's data book, some sketches made at a war-time plant show the method of collecting moisture at glass areas and how to prevent condensation on structural steel conducting cold from exterior walls. Conditioned space was held at 78 D.B. —60% R.H. in the summer, 72 D.B. —60% R.H. in the winter.

Inside walls were given two coats of aluminum paint to offer some resistance to moisture penetration. This also resulted in a clean looking and attractive appearance . Double glass was used with ¾ in. air space con-



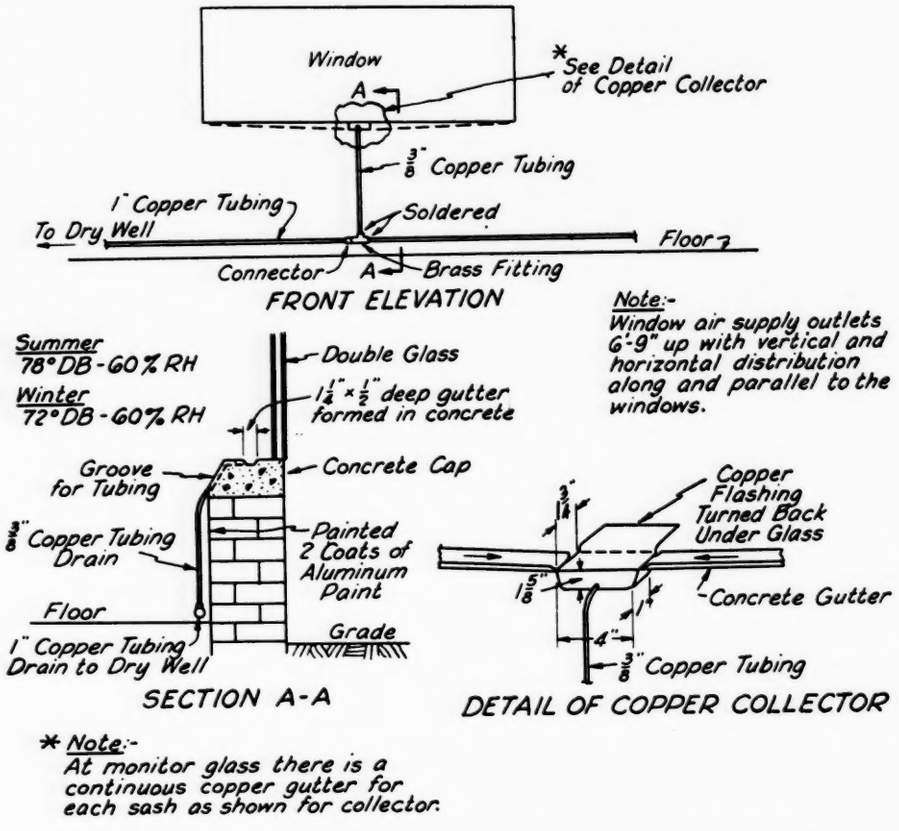

Connect to main supply fan, from washer.
Size this duct and outlets for 100% supply air
Size for shortest blow
Use pickup damper and long collar on each outlet, for proper air control
If high humidity maintained in winter with single glass, install drip gutter
On long side of building run duct over or under doors, preferably under, with slots in slit on room side
To booster fan and reheat coil
High pressure slotted window duct 1-½"x4" slot per 20 sq ft of window area, and/or spaced on 3'-0" centers
Size wall duct on 10 cfm per slot

HOW TO CARE FOR CONDENSATION: (Upper) Method of preventing condensation on steel conducting cold from exterior walls. (Lower) Duct system. Window shielded to prevent moisture.

Note: Mr. Reynolds is Chief, Air Conditioning Division, Abbott, Merkt & Co., Engineers, New York.

taining calcium chloride rolls. All glass areas and exhaust openings were provided with drip gutters, and beams entering the outside walls were insulated with 1 in. cork. All roof leaders at roof were also insulated with 1 in. cork. Window air supply outlets are about 7 ft up from the floor and fitted with registers having vertical and horizontal distribution along and parallel to the windows.

Also from the writer's data book is another method of dealing with high humidities. As shown in the illustration, booster fans deliver air at high pressure to slotted window ducts to prevent or minimize condensation where high humidities must necessarily prevail in process work. The system is zoned as noted. Each slot is sized ¼ in. x 4 in. for each 20 sq ft of window area; slots are spaced 3 ft on centers and each delivers 10 cfm of air.


Window
A
*See Detail of Copper Collector
3/8" Copper Tubing
1" Copper Tubing To Dry Well
Soldered
Floor
Connector
A
Brass Fitting
FRONT ELEVATION
Note:- Window air supply outlets 6'-9" up with vertical and horizontal distribution along and parallel to the windows.
Summer 78° DB - 60% RH
Winter 72° DB - 60% RH
Double Glass
1¼" x ½" deep gutter formed in concrete
Concrete Cap
Groove for Tubing
3/8" Copper Tubing Drain
Painted 2 Coats of Aluminum Paint
Floor
Grade
1" Copper Tubing Drain to Dry Well
SECTION A-A
Copper Flashing Turned Back Under Glass
Concrete Gutter
1 5/8"
4"
3/8" Copper Tubing
DETAIL OF COPPER COLLECTOR
* Note:- At monitor glass there is a continuous copper gutter for each sash as shown for collector.

HOW TO CARE FOR CONDENSATION: Method of collecting moisture at glass areas.

FIRST THINGS FIRST

As a rule a draftsman never has to do other than draft his plan. He never has to use it in the field or quickly consult it at a conference. If he did he might view his plans quite differently, putting first things first, like apparatus numbers which must first be located before details are pondered over .

Practically every plan of an apparatus room needs at least two sections, but usually only one is provided and sometimes none at all. Sections quickly portray the picture, bring out the mistakes we otherwise would not be aware of and save many a headache in the field. The erector quickly gets the idea of what is wanted, bothers you less, and time is saved all around.

In our haste to get things started on the site or to make a token display of being on time, we rush plans to the field prematurely. Yet a job started too soon ends too late due to field changes. The best way is to take time to develop the errors in the office. It pays to be fussy about all these things. When the writer had his own home built the contractors failed because they had not figured on the owner haunting the job. The contractors and workmen said he was fussy, yet each thing that the writer was talked out of has remained throughout the years to plague him.

SAVE NOW, SPEND LATER

If we are committed to the thought that present day prices will not be as abnormal in the near future as they are in the present, then it would seem most wise to buy only the cheaper materials now, even though this procedure may increase the maintenance costs of some other day. If labor and materials will be eventually cheaper, we can well afford to pay in the future for increased maintenance, and possibly even replacement, out of the savings in first cost now made. Whether or not such reasoning proves right in the long run, we should at least re-examine our specifications with a view to revisions in the light of present day high costs.

Magnesia covering, frequently specified for low pressure steam pipe, is another example of questionable expenditure. Here, again, we have a material cost that is practically double and a labor cost that is about equal to that of the cheaper material, such as air cell covering.

In connection with fresh air louvers and goose necks on the roof for fan discharge, can copper be substituted for Monel metal, or galvanized iron painted, for the copper? Would not weather type fans exposed on the roof be cheaper than pent houses for fans and require less painting? Could we not get along with radiation supported from the floor rather than the wall? Isn't it feasible in some types of installation to use radiation of the finned type which is more or less continuous? Such radiation can be hung easily, distributes heat uniformly, saves on runouts, traps and valves and there is much less weight to handle.

Small branch pipes or runouts from covered heating mains need not be insulated. They cannot overheat the building, nor can the return mains. Small pipes cost about as much for labor to cover as do larger pipes of the next few sizes; furthermore, there is less flash at the pumps where returns are not covered.

Quite often expansion pipe loops are specified in lieu of sliding expansion joints with a mistaken view to economy. Such loops are not of good appearance and they usually double the installation cost. A loop costs more for erection and requires separate anchors and guides and there is a considerable cost for insulation, canvasing and painting. For example, a 4 in. loop requires 24 l.f. of insulation.

In addition to savings made by substituting cheaper material, there are still other savings which can be made by changes in the design, or by deferring certain portions of the work which can be done later without much inconvenience. Piping identification systems, for example, can well await some other time, while double ducts for combination supply and return outlets at the ceiling is an expenditure that can be decreased by using supply only and a few exhaust inlets to a small amount of exhaust ducts.

JUST MOMENTS

Time was flying by. A couple of minutes were left. The day was hot, the seat was hard, but there was the examination direction, "Define bending moment." The applicant for a professional engineer's license knew heating, but must be learned in structural engineering or no license would be granted. So he wrote quickly in the space provided, "Bending moment is the moment it bends."

Factors in the Design of Cyclone Dust Collectors

MELVIN W. FIRST
and
LESLIE SILVERMAN

Department of Industrial Hygiene,
Harvard School of Public Health

Factors in the Design of Cyclone Dust Collectors

MELVIN W. FIRST

Research Fellow, U. S. Public Health Service, Harvard School of Public Health, and

LESLIE SILVERMAN

Associate Professor of Industrial Hygiene, Harvard School of Public Health

Basic factors in the design and performance of cyclone dust collectors. Theoretical and empirical formulas for cyclone performance that are now available indicate that some minor constants must be determined through experiment; they indicate the need for additional information regarding the cyclone collector.

PERHAPS the most widely used dust collector in industry is the cyclone or centrifugal collector, because of its simplicity, ruggedness and low operating cost. It has become the air cleaner of choice for particles ranging downward in size to 20 microns. Cyclones are commercially available for which the manufacturers indicate high efficiency for particles as small as 5 microns and research continues for designs that will give high retention on smaller sizes.

Within surprisingly wide limits the cyclone will function provided (1) the power input is unrestricted and (2) not too severe a requirement as to the minimum particle size to be separated is imposed. For collection of particles below 25 microns and for maximum efficiency careful design is necessary.

Types of Cyclones

Cyclones may be classified as follows:

(1) Simple cyclones, Fig. 1, in which the path of the conveying gas is unimpeded, traveling downward from a tangential inlet and then upward to a central exit.

(2) Complex cyclones, in which the path of the conveying gas is modified by means of specially designed inlets, stationary or rotating internal parts, modified outlets or mechanical dust traps.

(3) Compound cyclones, in which the flow through the apparatus is divided into a number of separate paths by means of baffles and partitions; or in which the conveying fluid is divided into a cleaned fraction which is discharged, and a concentrated fraction receiving further treatment.

In simple cyclones the particulate matter is thrown out of the gas stream radially by centrifugal force, arrested in the slow-moving gas layer at the outer cyclone wall and allowed to settle by gravity into a collecting bin. The cleaned gas ascends the central portion of the apparatus and leaves through the exit duct. In spite of intricate design, complex and compound cyclones have not, in general, given results economically superior to well designed simple cyclones.

Cyclone Variables

Cyclone performance is governed by operating variables involving fluid properties and flow rates of the solids and gases handled, and by design variables influenced by the physical characteristics of the housing.

Design variables at the present time have been limited only by the imagination of the designer. The

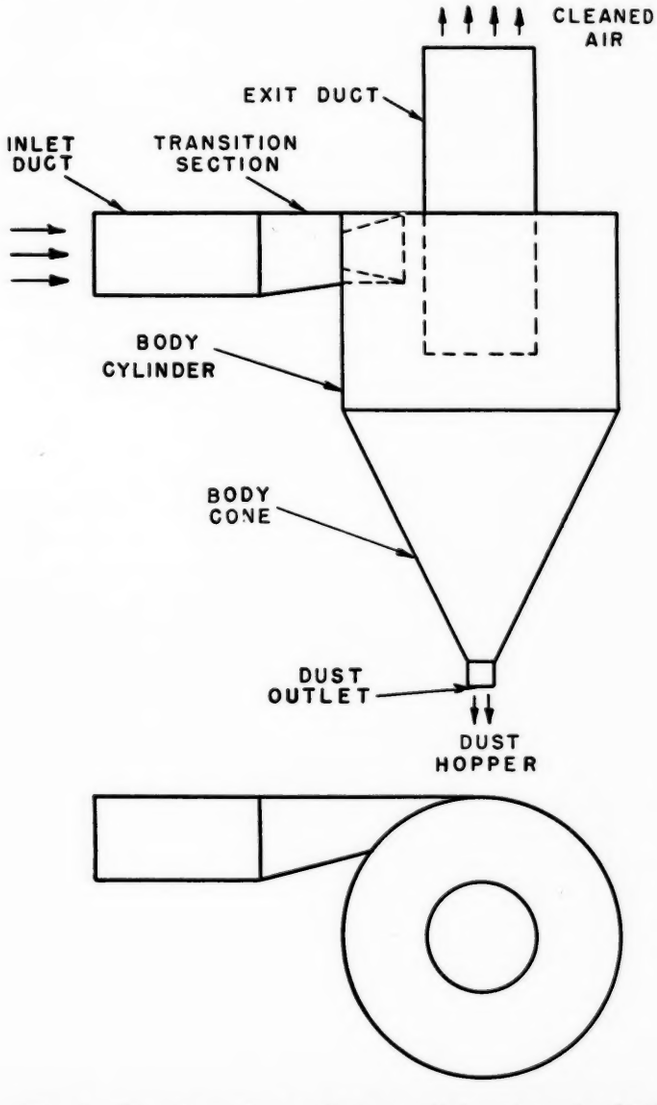


Fig. 1. Simple cyclone with tangential rectangular inlet.

Symbols Used in the Article

a = Height of rectangular cyclone inlet, ft
A = Area of cyclone inlet, sq ft
A_t = Cross section area of tangential air stream in cyclone, sq ft
b = Width of rectangular cyclone inlet, ft
C = A constant to be experimentally determined
d = Diameter of solid particle, ft
$d_{(min)}$ = Smallest size particle separated at close to 100% efficiency, ft
D = Diameter of cyclone cylinder, ft
E = Diameter of exit duct, ft
f = A constant to be experimentally determined
F_c = Energy loss due to contraction of air stream, ft lb (force) per lb (mass)
F_{cv} = Cyclone pressure loss (number of inlet velocity heads)
F_e = Energy loss due to expansion of air stream ft lb (force) per lb (mass)
F_i = Friction loss due to loss of energy in the inner gas spiral (number of inlet velocity heads)
g = Gravitation constant, ft per second squared
h = Cyclone pressure loss, in. of water
k = Proportionality factor relating area of cyclone inlet A to area of gas path in cyclone A_t
K = Proportionality factor relating properties of non-spherical dusts to those of spherical particles
K' = A constant to be experimentally determined
L = Over-all length of cyclone, ft
m = Proportionality factor defined by

$$\frac{S}{NV_t} = m\frac{W}{\left(\frac{Q}{A_t}\right)\left(\frac{L}{D}\right)}$$

N = Number of revolutions of gas stream in cyclone
p = Experimentally determined constant
Q = Gas flow rate, cu ft per sec
r = Radius of curvature of gas path (or particle path) in cyclone, ft
r_1 = Radius to some point in cyclone body, ft
r_1' = Inner radius of inner gas spiral, ft
r_e = Radius of inner boundary of outer gas spiral, ft
r_v = Radius at which the inner gas spiral has a velocity equal to entrance velocity, ft
S = Radial separating distance in cyclone, ft
t = Time, seconds
u = Experimentally determined constant
V_e = Inlet velocity of gas stream, ft per sec
V_t = Rotation velocity of gas stream at some radius, r_1, ft per sec
V_r = Radial velocity of particle, ft per sec
V_t = Tangential velocity of gas stream, or particle, ft per sec
V_{TS} = Terminal settling velocity of particle in still air, ft per sec
$V_{TS(min)}$ = Minimum terminal settling velocity in still air of particles that are separated at close to 100% efficiency, ft per sec
W = Width of circular space between cyclone body and exit duct, ft
y = Coefficient of contraction
α = Defined by

$$\alpha = \left[\frac{9\mu}{\pi(\rho_s - \rho_a)} \cdot \frac{k}{KK'}\right]^{1/2}$$

β = A constant to be determined experimentally
γ = A constant to be determined experimentally
θ = Angular travel of gas path or particle, radians
ρ_a, ρ_s = Density of solid particle and gas, respectively, lb per cu ft
μ = Absolute viscosity, lb per ft sec

common design variables of a simple cyclone are (1) the diameter of the cyclone body (commercially available models range from approximately 5 in. to 15 ft or more); (2) length-to-diameter ratio (ranging from 1.25 to 6 or more in commercial models); (3) area and shape of inlet and exit duct; and (4) position and depth of exit duct within the cyclone body.

A system handling air-dust mixtures will include operating variables of density, viscosity and air flow rate through the apparatus. The physical properties of the gas, in addition to its flow rate, influence the aerodynamic pattern around the solid particle and consequently the particle resistance to separation. These factors also affect the magnitude of the over-all friction loss.

Size, shape, surface characteristics and density of the particulate matter are other important factors. For non-uniform dusts, geometric mean diameter and size-frequency distribution may be utilized to express particle size. Unfortunately, particle shape is difficult to assess objectively; surface texture is also a significant property which is hard to evaluate; and finally the determination of density on sub-sieve sized particles is not easily performed. Foley suggests the use of terminal settling velocity of particles in still air as a parameter which combines all the significant physical properties of dusts to be separated in cyclone type apparatus into a single numerical value.

Cyclone Performance

Two significant factors in practical cyclone design are separating efficiency and pressure loss through the apparatus. Efficiency may be expressed as weight percentage of material retained; as percent of particles retained of a definite or mean size; or as the minimum size particle completely retained. Cyclone pressure loss is an index of power consumption and, of course, influences operating cost.

Cyclone Flow Pattern

An adequate quantitative description of the flow pattern within a cyclone is not available in the liter-

ature. A majority of investigators have reached the conclusion that the entering stream forms a downward-moving outer spiral which persists throughout the entire length of the cyclone body, gradually transferring fluid (below the exit duct entrance) to an upward moving inner spiral of smaller radius flowing into the exit duct. Vortical gas motion persists for a considerable length upstream in the exit duct. Shepherd and Lapple state that the outer radius of the inner spiral is approximately equal to the outlet duct radius. Transfer of fluid from the outer to the inner spiral apparently begins immediately below the exit duct inlet and continues down into the cone to a point near the dust outlet at the bottom. They observed on their experimental cyclone that the average downward angle of flow in the outer spiral was approximately 10° with the horizontal, or just enough to prevent conflict between successive revolutions of the fluid stream.

On the other hand, Wellmann and Van Tongeren, on the basis of observations and theoretical considerations, conclude that double-eddy type flow occurs in cyclones and draw an analogy to flow in circular pipe bends where such a flow pattern occurs. The existence of an orderly stream-tube in the form of a double spiral is not incompatible with the concept of a double-eddy type flow super-imposed around the axis of this imaginary double spiral stream-tube as it flows through the cyclone.

Cyclone Separating Efficiency

Before turning to a consideration of the separating forces in a cyclone it should be stated that the laws of particle motion to be discussed are not strictly applicable to moving gases, particularly where the motion is highly turbulent. Nevertheless, for practical purposes it may be assumed that the rate of motion of the particle relative to the gas stream is proportional to the net separating force and that the resisting force depends on the same factors as the separating force. Departures from strict conformation to theory thus tend to nullify each other.

Stokes' Law may be conveniently stated as

$$V_{TS} = \frac{g}{18} \frac{(\rho_s - \rho_a)}{\mu} d^2 \qquad (1)$$

Where: V_{TS} is the terminal settling velocity of a spherical particle settling under the force of gravity in still air; g is the acceleration of gravity; ρ_s and ρ_a are the density of the solid particle and the conveying gas, respectively; μ is the absolute viscosity of the gas; d is the diameter of the spherical particle. Equation (1) states that the terminal settling velocity of a spherical particle is still air is solely a function of the density and size of the particle for air at ordinary temperature and pressure since g, ρ_a and μ are physical constants.

If the radial acceleration of a particle in a centrifugal field (expressed by $\frac{V_t^2}{r}$ where; V_t is the tangential velocity of the particle: and r, the radius of curvature of the path) is substituted for g in (1)

$$V_r = \frac{V_t^2}{18r} \frac{(\rho_s - \rho_a)}{\mu} d^2 \qquad (2)$$

Here, V_r is the radial velocity of the particle and hence the separating velocity. It can be shown that sub-sieve size particles reach their terminal velocity almost as soon as they start to fall or are acted on by a centrifugal field and no appreciable error is introduced by neglecting the initial brief acceleration of the particle. For practical application to small particles the tangential velocity of the particle may then be taken as equal to the tangential air stream velocity. Radius r is defined for a point condition but an average r may be substituted.

A particle in simple rotational motion will traverse a distance r θ during the time interval

$$t = \frac{r\theta}{V_t} \qquad (3)$$

where: θ is the angular travel expressed in radians.

During this same interval a particle under the influence of centrifugal force will travel a radial distance S such that

$$S = V_r t \qquad (4)$$

where t is time. Substituting (3) into (4) yields,

$$S = \frac{r\theta}{V_t} V_r \qquad (5)$$

Now, substituting (2) into (5) and simplifying, we obtain

$$S = \frac{\theta}{18} V_t \frac{(\rho_s - \rho_a)}{\mu} d^2 \qquad (6)$$

If N represents the total number of revolutions of the air stream in the cyclone, the total angular travel, θ, becomes $2\pi N$. Substituting $2\pi N$ for θ and solving for d, equation (6) becomes

$$d_{(min)} = \left[\frac{9\mu}{\pi (\rho_s - \rho_a)}\right]^{1/2} \left[\frac{S}{N V_t}\right]^{1/2} \qquad (7)$$

This equation indicates that the minimum size spherical particle separable in a simple cyclone is dependent upon a group of physical constants and an expression involving the width of the air stream in the apparatus, the number of turns of the stream, and the tangential velocity of the air stream. In this, $d_{(min)}$ is defined as the smallest size particle separated at approximately 100% efficiency.

Of the dust particles entering the cyclone, those at the inner boundary of the gas stream (closest to the exit dust wall) are in the least advantageous location for separation since they have the greatest radial distance to travel before reaching the cyclone wall. Decreasing the air stream width, makes it possible for smaller particle sizes to reach the outer cyclone wall from the inner air stream boundary. See Fig. 2. An increase in the number of turns of the air stream in

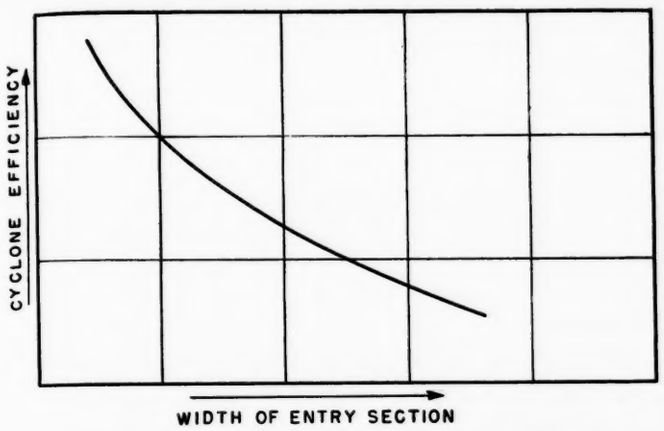


Fig. 2. Cyclone efficiency (weight retention basis) vs width of entry section. (Adapted from Rosin).

the apparatus results in a longer period during which the separating force will be applied and hence smaller particles can reach the wall for separation. See Fig. 3. Finally, increase in tangential velocity increases the separating force and again decreases the size particle separated as shown in Fig. 4.

For a cyclone of fixed dimensions, air flow rate and specified dust, conditions will be such that a minimum-size particle can enter the cyclone at the lease advantageous position and always have just sufficient radial velocity and retention time to reach the outer wall. Particles smaller than those defined by $d_{(min)}$ will also be collected when they enter the apparatus close to the outer wall. All particles and aggregations of particles larger than $d_{(min)}$ are theoretically completely separated.

It may be noted that a particle that reaches the inner ascending spiral can be thrown into the outer descending spiral because of the greater centrifugal force exerted by the smaller-radius inner spiral. A particle may thus make several passes through the ascending and descending air streams before separation or leaving through the exit duct.

In cyclones of usual proportions, air stream width S will be very nearly equal to the width of the annular space $\frac{D-E}{2} = W$; where D is the diameter of the cyclone cylinder and E is the exit duct diameter. The number of turns, N, the air stream makes in cyclones of usual proportions is directly related to the length-to-diameter ratio L/D and, within wide limits, is independent of air flow rate. For a given cyclone the air stream tangential velocity is directly related to volume rate of air flow Q if it is assumed that the cross-sectional area of the vortical air stream A_t is only slightly affected by variations in Q. For air at ordinary temperatures and pressures, and for a stated density of spherical dust particle, $d_{(min)}$ will depend only upon the variables W, Q, and L/D in the relationship given below:

$$d_{(min)} = f\left[\frac{W}{Q\left(\frac{L}{D}\right)}\right]^{1/2} \qquad (8)$$

where f represents an experimentally determined numerical constant having a value equal to

$$m\left[\frac{9\mu A_t}{\pi(\rho_s - \rho_a)}\right]^{1/2}$$

where m and A_t are unknown. The proportionality m factor is expressed in

$$\frac{S}{NV_t} = m\frac{W}{\left(\frac{Q}{A_t}\right)\left(\frac{L}{D}\right)}$$

For the practical situation of non-spherical dusts, Eq. (7) may be modified by inclusion of a factor K which value is determined by relative shape and surface texture of the dust as follows:

$$d_{(min)} = \left[\frac{9\mu}{\pi(\rho_s - \rho_a)}\right]^{1/2}\left[\frac{S}{NV_t}\right]^{1/2}\left[\frac{1}{K}\right]^{1/2} \qquad (7a)$$

Attempts have been made to assign values to K such that irregular particles may be assumed to behave as uniform theoretical spheres of some diameter d, although these efforts have not met with a great deal of success.

To alleviate this difficulty to some extent, it has been suggested as mentioned that terminal settling velocity of dust in still air be utilized; thus combining the physical properties of shape, size, density and surface texture into a single value. Using Eq. (1) and the correction factor K, Stokes' law for non-spherical particles may be expressed as follows:

$$V_{TS} = \frac{g}{18}\frac{(\rho_s - \rho_a)}{\mu}d^2K \qquad (1a)$$

If (1a) and (7a) are combined and simplified then,

$$V_{TS} = \frac{g}{2\pi}\frac{S}{NV_t} \qquad (9)$$

The factor K is thus eliminated. Of the four variables in Eq. (9), none is easily measured and the direct application of this equation to cyclone design is not

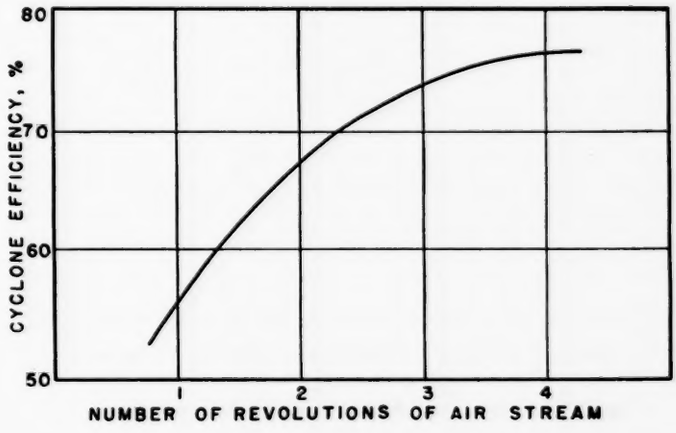


Fig. 3. Cyclone efficiency (weight retention basis) vs number of revolutions of air stream in cyclone. (Adapted from Leckie).

great. However, Eq. (9) can be simplified by substituting W, $\frac{Q}{A_t}$ and $\frac{L}{D}$ for S, V_t and N, respectively, as in Eq. (8), or

$$V_{TS\ (min)} = C \frac{W}{Q\left(\frac{L}{D}\right)} \qquad (10)$$

where C is a numerical constant determined experimentally, and having a value equal to

$$m \frac{g}{2\pi} A_t$$

where m and A_t are unknown. W, Q, and L/D are easily measured quantities and V_{TS} may be determined in a suitable elutriating apparatus. Eq. (10) applies to any type particle, leaving only the value of C to be determined by experiment.

Cyclone Pressure Loss

The total pressure loss through a cyclone results from mechanical energy loss and pressure change due to differences in area of entrance and exit ducts. If inlet and exit duct cross-sections are equal, the latter component of the total pressure loss will disappear provided readings are taken down stream at a point where the swirling flow existing in the exit duct as it leaves the cyclone body is damped out.

Mechanical energy losses in cyclone separators resulting from wall friction in the cyclone chamber are believed to be small when compared to the total air stream energy, and except in cases of low flows, where friction losses become proportionately greater, the losses are neglected. Minor friction losses above those anticipated by application of the Fanning friction formula occur in the exit duct from swirling gas flow which in effect serves to increase the gas velocity as well as the rubbing surface of the pipe.

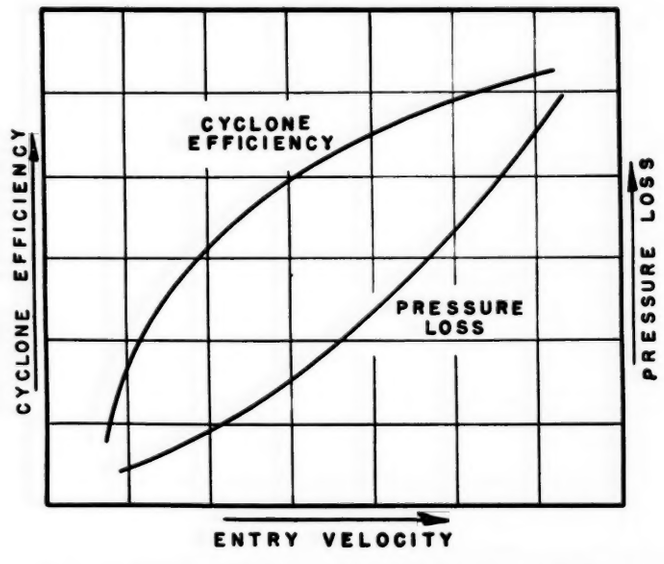


Fig. 4. Cyclone efficiency (weight retention basis) vs entry velocity cyclone pressure loss vs entry velocity. (Adapted from Leckie, Rosin, Whiton and Feifel).

As the exit duct flow becomes rectilinear, some pressure energy regain may occur. However, regain under these conditions is also considered insignificant. Additional mechanical energy losses occur at entry and in the transition piece which converts pipe to entry velocity. Energy loss, F_e, due to sudden expansion of the air stream as it enters the cyclone body is expressed by:

$$F_e = \frac{(V_e - V_t)^2}{2g} \qquad (11)$$

V_e, velocity at entry, equals Q/ab where a and b are sides of the rectangular inlet, but V_t, tangential velocity of the gas stream in the cyclone body, is less easily determined. Although the radial distance between the exit duct and cyclone body wall W controls lateral expansion or contraction of the entering gas stream, the extent of vertical expansion is not known. For usual operating conditions, entry loss is small. Losses in well-tapered, smooth transition sections increasing or decreasing the pipe velocity at entry are also low. For the usual case of a small contraction in area, to take advantage of an increased entry velocity, the energy loss due to contraction, F_c, is as follows:

$$F_c = y \frac{V_e^2}{2g} \qquad (12)$$

where y is the contraction coefficient (a function of the ratio of inlet area A to duct area down stream of transition piece). For smooth, gradually-tapered transition sections, the value of y is only about 0.05. For an enlarging transition section Eq. (11) can be applied. Since the enlargement is usually small, the difference $V_e - V_t$ and the value of F_e will also be small.

The major source of mechanical energy loss in the cyclone is kinetic energy of rotation of the gas stream which is not subsequently converted back to pressure energy after leaving the apparatus.

Shepherd and Lapple, assuming that the kinetic energy of the outer spiral contributes to kinetic energy of the inner spiral and induces no loss in itself, express the rotation velocity distribution in a cyclone as follows:

$$V_i = \frac{u}{\sqrt{r_i}} \qquad (13)$$

where V_i is the rotational velocity at a radius r_i and u is a constant determined on a theoretical basis from the average rotational kinetic energy per unit mass of air in the inner spiral. Since it is assumed that little or none of this energy is recovered, this constitutes the friction loss due to the inner spiral. On this basis the friction loss F_i, expressed as number of inlet velocity heads is:

$$F_i = \frac{r_v}{\sqrt{r_o r_i'}} \qquad (14)$$

where r_v is the radius at which inner spiral velocity is equal to entrance velocity; r_o is the radius of the inner boundary of the outer gas spiral; r_i' is the inner radius of the inner spiral. The inner radius of the

outer spiral, r_o, is believed equal to exit duct diameter, E, but values of r_v and r_1' are not available.

A number of empirical expressions for cyclone pressure loss appear in the literature. None of these agree with each other closely except that all include similar variables. These empirical formulas usually have the following general form when rearranged with necessary substitutions:

$$Q = K'A\frac{E}{D}\sqrt{h} \qquad (15)$$

where A is the area of cyclone inlet

h is the cyclone pressure drop

K' is a constant to be determined experimentally, and the other symbols are as previously defined. Values of K' reported in the literature have failed to agree. The wide range of values shown in Table 1, adapted from Alden "Design of Industrial Exhaust Systems," clearly indicates the present lack of knowledge on cyclone pressure loss.

Shepherd and Lapple, on the basis of experiments with a 12 in. diameter cyclone having an L/D ratio of 4, and exit duct diameter of 5 5/8 in. proposed a cyclone pressure loss formula as follows:

$$F_{cv} = p\frac{a\,b}{E^2} = p\frac{A}{E^2} \qquad (16)$$

where: F_{cv} is the pressure loss expressed as number of inlet velocity heads. For a simple cyclone with tangential rectangular inlet and entry deflector vane the value of the constant p is reported equal to 7.5. For the same cyclone without the inlet deflector vane, p = 16. Converting Eq. (16) into the same form and units as Eq. (15), values of K' based on Shepherd and Lapple's formulas are shown in Table 2. There is good agreement between values of K' shown in tables 1 and 2 but not in the calculated and measured pressure losses.

Table 1 – Comparison of 9 Proposed Pressure Loss Conditions

(Adapted from Alden)

Cyclone Resistance Calculated From $h = \left(\frac{Q}{A}\cdot\frac{D}{E}\cdot\frac{1}{K'}\right)^2$ $V_t = \frac{Q}{A}$ = 107 ft. per sec. $\frac{D}{E}$ = 2.21		% Error in Calculated Pressure Loss Compared to Observed Pressure Loss	
		Cyclone Without Inlet Deflector	Cyclone With Inlet Deflector
K'*	h In. Water	Actual Loss = 5.10 In. Water	Actual Loss = 2.92 In. Water
306	0.54	—89	—82
147	2.59	—49	—11
144	2.69	—47	— 8
116	4.17	—18	+43
102	5.41	+ 6	+85
97	6.04	+18	+107
83	8.34	+63	+186
75	10.04	+97	+244
57	16.67	+227	+471

*Reported values of K' for calculating cyclone pressure loss after conversion to same units.

Table 2 – Values for Cyclone Pressure Loss Equation Experimental Constant K'

(Adapted from Shepherd and Lapple)

Area of Inlet Sq Ft	Values for K' for Use in Eq. (15) $h = \left(\frac{Q}{A}\cdot\frac{D}{E}\cdot\frac{1}{K'}\right)^2$	
	Cyclone Without Inlet Deflector	Cyclone With Inlet Deflector
.057	68	101
.1093	47	70
.125	44	66

Cyclone Pressure Loss and Efficiency

If the expression for cyclone efficiency is combined with that for cyclone pressure loss an equation is developed which indicates the two significant factors of cyclone performance.

Since

$$Q = V_t \cdot Ak \qquad (17)$$

Where k is a constant that relates the cyclone inlet area to cross sectional area of the gas path in the cyclone body. Combining Eq. (15) and (17) we get

$$V_t = \frac{K'}{k}\frac{E}{D}\sqrt{h} \qquad (18)$$

Substituting (18) into (7a) gives the following expression:

$$d_{(min)} = \left[\frac{9\mu}{\pi(\rho_s - \rho_a)}\cdot\frac{k}{KK'}\cdot\frac{SD}{NE}\cdot\frac{1}{\sqrt{h}}\right]^{1/2} \qquad (19)$$

For air at ordinary temperature and pressure (70F and 30 in. of mercury) and for a specified dust, the portion

$$\left[\frac{9\mu}{\pi(\rho_s - \rho_a)}\cdot\frac{k}{KK'}\right]^{1/2}$$

is constant. Designating this term a and substituting for it in Eq. (19)

$$d_{(min)} = a\left(\frac{SD}{NE}\right)^{1/2}\left(\frac{1}{\sqrt{h}}\right)^{1/2} \qquad (19a)$$

Making substitutions for S and N as in Eq. (10) and introducing a new constant β then

$$d_{(min)} = \beta\left[\frac{W}{E}\cdot\frac{D}{\left(\frac{L}{D}\right)}\right]^{1/2}\left(\frac{1}{\sqrt{h}}\right)^{1/2} \qquad (20)$$

Equation (20) is an expression involving the physical dimensions of the apparatus, the minimum size

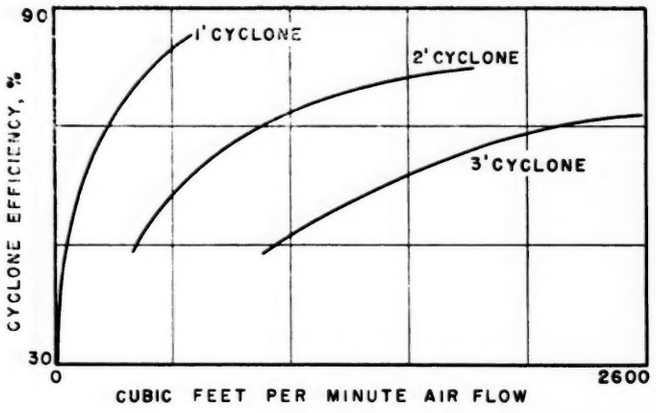


Fig. 5. Cyclone efficiency (weight retention basis) vs air flow rate for cyclones having body cylinder 1, 2, and 3 ft dia. (Adapted from Whiton).

particle of stated density separable at approximately 100% efficiency, and the pressure loss through the cyclone; the value of β is determined experimentally.

Alternatively, using terminal settling velocity instead of diameter of the particle, we get,

$$V_{TS\,(min)} = \gamma \frac{W}{E} \cdot \frac{D}{\left(\frac{L}{D}\right)} \cdot \frac{1}{\sqrt{h}} \qquad (21)$$

or substituting $\frac{D-E}{2}$ for W and rearranging, then,

$$V_{TS\,(min)} = \gamma \frac{1}{\left(\frac{L}{D}\right)} \left(\frac{D}{2}\right) \left(\frac{D}{E} - 1\right) \frac{1}{\sqrt{h}} \qquad (21a)$$

and the value of the constant γ, to be determined experimentally, is applicable to any dust.

Experimental results relating cyclone pressure drop, efficiency and dimensions from a number of investigators may be qualitatively compared to the derived expressions as follows:

Low efficiency cyclones (poor efficiency for particles less than 100 microns) usually operate at pressure loss of less than 1.5 in. of water. This type of cyclone has an $\frac{L}{D}$ ratio close to unity. On the other hand, high efficiency cyclones have $\frac{L}{D}$ ratios of 2 or more and show pressure losses of 2-4 in. This agrees with the derived expressions. From Eq. (21a) the influence of absolute size on efficiency (as expressed by the multiple appearance of the diameter D) is striking, and is in agreement with the known high efficiency of midget cyclones as shown in Fig. 5. Cyclone efficiency is directly related to air flow rate. Fig. 5 is in agreement with Eq. (21) and Eq. (21a) as efficiency is inversely proportional to the minimum size particle separated and pressure loss varies directly as the quantity of flow. Within certain limits as in Fig. 4, efficiency increases with increased pressure loss.

Problems Requiring Further Investigation

Theoretical and empirical expressions for cyclone performance now available indicate important design and operating variables in apparently their proper mutual relationship. A number of significant but probably minor variables are left unaccounted for in constants that must be determined by experiment. Since no universally applicable values for such constants have appeared it indicates a need for further investigation into the precise mechanisms of the cyclone dust collector.

Of the problems to be solved, that relating to the laws of mechanical similitude appears basic. In general, published data on cyclone performance are applicable only to the size and shape of apparatus actually investigated. Results obtained on experimental models have not been satisfactorily projected to full scale equipment because no attempt has been made to achieve mechanical similitude by application of geometrical dimensional analysis. This necessarily restricts practical cyclone investigation to time-consuming trial and error methods.

Existing qualitative descriptions of the flow pattern within a cyclone do not agree and an adequate quantitative analysis is necessary. An expression of flow pattern combined with a knowledge of the laws of mechanical similitude applying to cyclones should prepare the way for application of data obtained on models to full scale equipment. This type of study can develop quantitative relationships between cyclone efficiency, pressure loss, dust characteristics and physical characteristics. In addition, the possible benefits to be derived from the use of the terminal settling velocity of a dust in place of size, shape, density and surface texture parameters is worthy of further study.

At the present time an investigation is in progress in this department to evaluate the important factors outlined.

NUMBER OF SUNSHINE HOURS IN HEATING SEASON

The accompanying table gives the number of hours by months the sun shines in a normal heating season in cities in the United States. These data are of some use in estimating the heat gain from the sun which may aid in the heating of buildings.

The data are from Weather Bureau maps for winter months. For the two months in which the heating season begins and ends, the weather data are proportioned according to the number of days. This introduces some inaccuracies but probably not serious ones, since the original data are not too accurate, in that the intensity of sunshine is not taken into account.

AVERAGE NUMBER OF SUNSHINE HOURS IN A NORMAL HEATING SEASON

State and City	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
ALABAMA													
Anniston	158	160	202	231	19	—	—	—	—	160	210	133	1273
Birmingham	158	160	198	339	—	—	—	—	—	117	210	130	1204
Gadsden	158	160	198	231	—	—	—	—	—	162	210	133	1252
Mobile	174	154	217	85	—	—	—	—	—	23	204	140	997
Montgomery	161	162	208	111	—	—	—	—	—	77	210	133	1062
Tuscaloosa	158	162	205	174	—	—	—	—	—	134	210	133	1176
ARIZONA													
Flagstaff	223	227	288	327	369	381	160	239	306	295	249	226	3290
Nogales	239	252	307	354	144	—	—	—	—	212	273	236	2017
Phoenix	233	241	301	69	—	—	—	—	—	—	264	236	1344
Yuma	236	252	202	—	—	—	—	—	—	—	200	239	1129
ARKANSAS													
Fort Smith	155	165	214	205	—	—	—	—	—	150	186	149	1224
Little Rock	152	162	208	211	—	—	—	—	—	142	189	146	1210
Texarkana	158	162	211	152	—	—	—	—	—	130	189	149	1151
CALIFORNIA													
Bakersfield	195	193	242	268	—	—	—	—	—	129	231	198	1456
Eureka	121	126	167	216	233	240	248	186	174	171	120	130	2132
Fresno	152	188	242	318	84	—	—	—	189	288	216	152	1829
Independence	195	199	254	306	276	—	—	—	56	298	234	186	1952
Los Angeles	217	196	236	270	279	45	—	—	—	100	225	217	1785
Pasadena	223	199	226	300	295	84	—	—	—	209	228	233	1997
Red Bluff	121	174	223	270	100	—	—	—	—	144	165	130	1327
Sacramento	133	185	239	309	257	—	—	—	—	202	195	140	1660
San Diego	217	207	248	285	276	216	—	—	—	220	237	239	2145
San Francisco	143	168	226	270	279	315	326	295	264	260	180	155	2881
San Jose	143	174	233	270	295	330	22	—	207	264	189	155	2282
San Luis Obispo	152	182	217	270	279	303	310	50	209	260	201	180	2613
COLORADO													
Boulder	205	207	246	276	288	131	—	—	187	248	207	192	2187
Colorado Springs	217	224	264	276	310	330	—	67	282	264	225	217	2676
Denver	211	210	248	273	295	109	—	—	182	254	213	198	2193
Grand Junction	180	193	248	282	286	—	—	—	105	257	213	183	1947
Pueblo	220	269	267	273	313	34	—	—	141	267	228	233	2245
CONNECTICUT													
Hartford	140	171	198	228	248	67	—	—	158	202	144	130	1686
New Haven	143	171	205	228	263	76	—	—	144	192	153	140	1715
DELAWARE													
Dover	155	171	202	231	182	—	—	—	40	220	180	152	1533
Milford	158	171	205	234	165	—	—	—	160	217	183	155	1648
Wilmington	146	168	198	228	174	—	—	—	48	214	171	146	1493
DIST. OF COLUMBIA													
Washington	149	168	195	231	173	—	—	—	32	217	177	143	1485
FLORIDA													
Jacksonville	183	179	224	—	—	—	—	—	—	—	195	164	945
Pensacola	177	182	220	60	—	—	—	—	—	—	195	140	974
GEORGIA													
Athens	158	162	205	213	—	—	—	—	—	175	198	143	1254
Atlanta	161	160	202	213	—	—	—	—	—	160	195	140	1231
Augusta	164	171	217	148	—	—	—	—	—	95	210	149	1154
Columbus	167	162	208	109	—	—	—	—	—	98	195	140	1079
Macon	167	165	217	158	—	—	—	—	—	111	192	146	1156
Rome	155	157	192	218	—	—	—	—	—	169	210	130	1231
Savannah	174	176	233	87	—	—	—	—	—	35	201	161	1067
IDAHO													
Boise	109	143	214	261	332	161	—	—	216	233	150	121	1940
Lewiston	78	118	198	246	295	82	—	—	174	205	108	78	1382
Pocatello	124	151	214	255	301	269	—	—	248	236	168	130	2096
ILLINOIS													
Aurora	124	154	195	243	295	21	—	—	162	205	153	118	1670
Bloomington	130	157	205	234	200	—	—	—	65	214	168	124	1497
Cairo	146	160	208	243	47	—	—	—	—	185	183	133	1305
Chicago	112	148	186	240	279	42	—	—	72	205	150	115	1549
Danville	124	154	198	228	162	—	—	—	58	217	165	121	1427
Decatur	127	157	205	231	200	—	—	—	66	217	168	127	1498
Joliet	121	154	195	243	295	21	—	—	138	223	153	118	1661
Peoria	133	160	205	240	259	—	—	—	128	211	165	127	1628
Rockford	124	154	195	240	279	42	—	—	156	198	144	118	1650
Springfield	140	160	208	237	200	—	—	—	41	217	171	130	1504
Urbana	124	157	202	231	257	—	—	—	108	217	165	121	1582

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State and City	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
INDIANA													
Evansville	136	154	198	231	95	—	—	—	—	204	174	124	1316
Fort Wayne	105	140	171	216	244	—	—	—	112	202	141	102	1433
Indianapolis	118	148	177	222	187	—	—	—	58	217	159	115	1401
South Bend	93	140	171	216	252	—	—	—	104	202	138	102	1418
Terre Haute	124	154	195	225	149	—	—	—	25	220	165	118	1375
IOWA													
Charles City	143	171	205	246	78	—	—	—	198	208	153	130	1532
Davenport	133	162	205	234	248	—	—	—	85	208	159	127	1561
Des Moines	152	171	214	237	238	—	—	—	86	220	165	140	1623
Dubuque	133	162	202	243	267	—	—	—	129	202	153	124	1615
Keokuk	143	165	214	225	167	—	—	—	47	214	168	133	1476
Marshalltown	146	171	208	246	273	—	—	—	139	217	159	133	1692
Sioux City	164	179	214	237	255	—	—	—	142	220	168	149	1728
KANSAS													
Concordia	186	188	236	255	202	—	—	—	35	242	207	167	1718
Dodge City	195	196	242	258	186	—	—	—	28	264	213	202	1784
Salina	186	188	236	252	169	—	—	—	9	242	201	171	1654
Topeka	171	179	229	237	167	—	—	—	26	233	189	158	1589
Wichita	180	185	236	243	140	—	—	—	—	494	192	171	1841
KENTUCKY													
Bowling Green	130	148	189	225	57	—	—	—	—	200	180	118	1247
Frankfort	109	143	171	216	120	—	—	—	25	220	159	109	1272
Lexington	105	140	171	213	155	—	—	—	16	217	156	109	1282
Louisville	124	148	186	222	94	—	—	—	—	204	168	118	1264
LOUISIANA													
New Orleans	171	149	217	—	—	—	—	—	—	—	156	149	842
Shreveport	161	165	211	96	—	—	—	—	—	81	186	149	1049
MAINE													
Bar Harbor	124	160	192	216	248	135	—	172	201	174	105	124	1851
Eastport	124	154	186	210	233	255	270	248	195	171	105	118	2269
Orono	109	168	195	222	233	257	—	51	204	171	105	109	1824
Portland	124	174	205	225	263	230	—	52	225	189	138	140	1965
MARYLAND													
Annapolis	146	168	195	231	153	—	—	—	48	217	177	146	1481
Baltimore	143	165	192	228	151	—	—	—	16	217	171	143	1426
Cambridge	155	171	205	231	121	—	—	—	—	220	183	152	1438
Frederick	93	126	186	192	160	—	—	—	70	155	120	93	1195
MASSACHUSETTS													
Boston	140	171	205	231	263	85	—	—	152	195	144	143	1729
Fitchburg	127	171	205	228	254	152	—	—	180	186	135	130	1768
Nantucket	146	168	208	231	267	261	—	—	173	198	156	155	1963
MICHIGAN													
Alpena	71	120	164	204	248	285	38	152	192	149	78	65	1766
Ann Arbor	96	132	180	204	273	76	—	—	187	180	114	84	1526
Calumet	102	140	189	231	254	294	304	239	189	133	96	74	2245
Detroit	96	129	177	204	279	57	—	—	137	180	114	78	1451
Escanaba	102	137	183	222	248	297	—	142	192	149	90	84	1846
Flint	93	132	180	204	270	124	—	—	222	177	105	74	1581
Houghton	105	140	189	231	254	294	59	172	189	136	96	78	1943
Kalamazoo	78	129	171	210	257	59	—	—	169	189	123	62	1447
Lansing	84	132	171	207	260	86	—	—	195	180	111	78	1504
Marquette	99	137	186	225	251	294	124	172	189	136	90	78	1981
Port Huron	109	129	177	204	273	162	—	—	192	174	105	74	1599
Saginaw	78	129	177	204	260	67	—	—	173	171	99	71	1429
St. Joseph	90	140	174	216	260	69	—	—	142	195	135	105	1526
Sault Ste. Marie	74	132	180	216	239	285	270	239	177	124	60	62	2058
MINNESOTA													
Duluth	127	162	195	243	247	291	319	257	207	148	114	99	2409
Minneapolis	140	171	202	246	264	69	—	—	180	186	135	121	1714
Moorhead	146	171	208	249	260	154	—	71	225	180	141	118	1923
Rochester	140	168	202	243	270	91	—	18	228	189	147	124	1820
MISSISSIPPI													
Meridian	161	165	208	162	—	—	—	—	—	126	210	136	1168
Vicksburg	158	165	208	100	—	—	—	—	—	80	198	146	1055
MISSOURI													
Columbia	149	165	214	234	171	—	—	—	33	223	180	140	1509
Hannibal	146	165	214	225	276	—	—	—	48	220	174	136	1604
Kansas City	164	176	226	228	150	—	—	—	25	229	186	152	1536
St. Louis	146	162	211	243	86	—	—	—	—	220	177	133	1378
Springfield	155	168	214	225	162	—	—	—	17	226	189	149	1505
MONTANA													
Billings	143	171	233	252	260	263	—	30	237	198	144	124	2055
Butte	115	151	220	249	264	294	363	329	246	205	138	115	2689
Great Falls	130	151	223	231	254	274	—	100	228	192	126	112	2021
Helena	124	154	220	243	257	272	105	124	237	198	135	112	2181
Havre	127	148	223	219	251	253	—	115	219	183	120	112	1970
Kalispell	84	120	211	231	248	285	198	260	222	171	87	62	2179
Miles City	149	176	229	249	267	102	—	—	211	195	147	140	1865
NEBRASKA													
Lincoln	177	182	226	249	235	—	—	—	74	229	180	155	1707
North Platte	189	190	239	261	279	54	—	—	194	239	201	171	2017
Omaha	167	179	220	240	205	—	—	—	63	226	174	149	1623
Valentine	177	185	233	255	273	106	—	—	168	220	183	158	1958
NEVADA													
Las Vegas	211	224	279	299	—	—	—	—	—	221	243	217	1694
Reno	140	174	246	285	326	320	—	12	324	264	201	140	2432
Winnemucca	146	182	251	285	341	262	—	—	315	254	195	161	2392

(Concluded on Reference Data Sheet 371-372)

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THE SALES ENGINEER

Meeting Customer's Objections

BERNARD LESTER
Sales Engineering Consultant

"IT beats all" complained the sales engineer, as he returned from a call on a prospect, "how many objections one fellow can raise. Price, design, performance . . . why he had me stumped."

In selling, it is well to remember that value is created and exists in the mind of the individual. It comes from proved facts and figures and from past experiences. But it also comes largely from impressions based upon mental images. Each of us regards objects through the distorted windows of his mind. All of us have prejudices—"lopsided" opinions.

Two ideas that spring from these observations can be used to shape the sales engineer's selling effort. One is the necessity of studying the individual prospect's likes, dislikes and opinions which usually are thrust at him in the shape of objections.

Let us cite a few of the objections commonly met by those who sell heating and ventilating equipment.

Your price is too high. Imagine a scale suspended before you. Suppose price rests on one end, and value —as humanly interpreted—at the other. Obviously the scale can tip in favor of the buyer by reducing price. Yet it is quite possible that the value would then drop, because the prospect starts to question whether his previous opinion of value is still accurate. Price is fixed, at one time at least, but value is changeable, depending upon the ideas and opinions of the prospect. Thus the problem of the sales engineer is to establish value—value at a high level—in the purchaser's mind. The price of two equivalent bids may be the same, but the opinion of value in the mind of the prospect may be quite different. Assuming value is present in a piece of apparatus—value in materials, design and workmanship—its extent or weight can be built through capable selling effort.

Your delivery is too long. We continually hear the expression, "We cannot wait for the delivery of your apparatus. Time means money to us. We can get the equivalent quicker." The first thing to find out is whether the prospect's statements are distorted. Certain accessories, or work on the part of other suppliers, may hold up the completion of the job. Then, again, are the competitor's delivery dates reliable? These points should be checked. If the sales engineer be convinced that his delivery is the real "bottleneck," then his job is to further establish value in the prospect's mind, to justify waiting for the longer delivery. Even in the case where the order is lost, some good has been done for the future in building up an opinion of value on the part of the prospect.

Your apparatus or installation may not produce the promised result. Meeting this objection usually revolves around establishing the value of the sales engineer's technical skill, and his company's reputation as an able performer. Of course engineering skill is a matter of value to the purchaser. It must be sold just as much as designs, materials and workmanship. Reference to past accomplishments may be important in establishing its value. We all know a poorly operating machine or installation is a millstone around the neck of the sales engineer.

Your apparatus is questionable because it is a new design. New designs may always be questioned. The prospect probably thinks, "why pick on me as a guinea pig—how do I know it will work?" Selling under these conditions requires preparation. Meet the objection, if possible, before it is voiced. Get across the idea that the prospect has been selected because he is progressive; that endless tests have preceded this new design; show how the new features are able and trustworthy to give better results. Better performing apparatus, too, will always place the purchaser in a perfect position to serve his customers, and lead his competitors.

Your apparatus is new to us—we want to keep a uniform make. "All our fans and blowers are bought from X," says the prospect. "We want to keep them uniform—it saves in maintenance." It is very often true that where one supplier gets all the business, his position is a precarious one. The sales engineer obtaining the business often becomes lax. Furthermore, with only one supplier, the purchaser has no means of comparing the service he gets with that of other possible suppliers. Again, the sales engineer's job is that of establishing value in the prospect's mind. The way is open to dwell upon worthwhile features in the apparatus he sells, for his competitor probably thinks this sort of sales effort is unnecessary. The sales engineer can point to the value of two sources of supply, illustrating this with an apt example. He can even stress the fact that his effort—his repeated calls on the prospect—serve to keep his competitor in line, and this effort deserves recognition in the way of some orders. No make of apparatus is entirely free from trouble. Finding out competitors' troubles are helpful.

Objections need not always be regarded as obstacles for the sales engineer. They always should be sign posts to guide the attack and the selling argument. They serve to reveal the mind and thinking of the purchaser.

Joints for Plumbing and Laboratory Piping

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The second section of a two-part article dealing with joints for sanitary piping and piping serving laboratory equipment. This article, which is part of a general series on methods of joining pipe, covers Duriron, chemical tile, plastic and glass pipe.

DURIRON PIPE

DURIRON pipe is commonly made in bell and spigot pattern of the same dimensions as extra heavy soil pipe.

When making joints, a slight space should be left between the end of the spigot and the bottom of the hub as shown in Fig. 1, so that metal to metal contact, or a joint so tight, that expansion will cause strain, is avoided. At least two rings of pure asbestos rope packing, impregnated with an acid resisting graphite or mastic, should be placed at the bottom of the hub and packed tightly. The remaining space should be filled with molten lead at moderate temperature. In cold weather hubs may be preheated with a blow torch before the lead is poured.

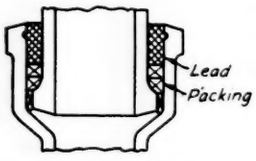


Fig. 1. Joint for Duriron pipe.

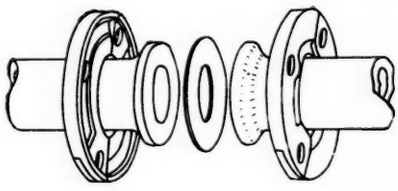


Fig. 2. Duriron split flange assembly.

Hemp or oakum should not be used for packing as they are not acid resisting. Dry asbestos rope does not make a satisfactory seal and should not be used.

For service at atmospheric temperatures, below 120F, the manufacturers recommend the use of Duriron No. 150 packing and for higher temperatures Duriron No. 160 packing.

Welded Joints for Duriron Pipe

Duriron pipe may be readily welded by use of the oxyacetylene flame. Careful preheating and cooling of the parts to be welded are necessary. Special Duriron welding rods should be used, making the resulting weld as acid proof as the balance of the pipe or fitting.

Split Flanged Joints

Where pressures of only a few pounds are to be carried in the line, Duriron bell and spigot joints are satisfactory, but where there is appreciable pressure the use of flanged pipe is necessary.

With this type of joint as shown in Fig. 2, a shoulder is provided at each end of a piece of pipe or fitting. The face of each shoulder is ground to insure smooth parallel surfaces on adjoining sections that will provide even seating over the entire face of the joint, and in back of each shoulder a split flange of malleable iron is provided. These flanges are light and flexible enough to accommodate themselves to any possible high spot on the pipe shoulder and thus to assure an absolutely flush joint. The flanges may be turned to any angle to meet bolt holes in another standard flange.

Gaskets of Durabla, a composition of asbestos and rubber that is almost universally acid proof, are furnished for installation between the finished faces of shoulders on adjacent sections of pipe.

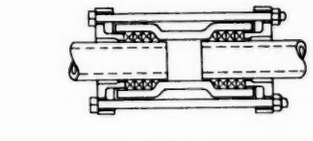
When making a Duriron split flanged joint, consideration must be given to:

(1) Adequate support for the joint.
(2) Proper alignment before tightening the flanges.
(3) Due allowance for expansion.

In horizontal lines, unless the pipe line is supported by a V trough or channel, it is advisable to support each joint. By placing the support near the joint, the installation is easier, particularly in securing the proper alignment at the flange faces.

Joints should not be bolted together until the flange faces are parallel.

As the coefficient of expansion of Duriron is about three times that of cast iron, it is necessary when installing long runs, where there are wide variations in temperature, to provide an expansion joint as shown in Fig. 3 about every fifty feet. Fig. 4 shows an expansion joint for use with bell and spigot Duriron pipe.



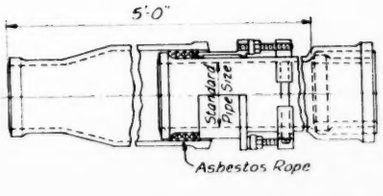


Fig. 3, upper. Duriron split flange expansion joint. Fig. 4, lower. Expansion joint for use with bell and spigot Duriron pipe.

iron pipe. In each case the packing material is asbestos rope.

Duriron Pipe Joints for Tanks

A special outlet pipe of Duriron, Fig. 5, is set in acid-proof cement in the base of the tank. Threads are cast on the body of the outlet pipe, and a bead for use with a split flange is provided on the lower end. Below the gasket a locknut of softer metal, Alcumite, is provided.

The rough sand cast surface of the Duriron cuts the softer Alcumite to allow a tight, nonslipping lock when the last fraction of an inch is pulled up on the nut. The Alcumite locknut is not subjected to bad corrosive conditions when the Duriron tank outlet has been properly cemented in place.

CHEMICAL TILE PIPE

The eight following types of joints are used with chemical tile pipe and fittings:

(1) Bell and spigot, for poured mastic joints
(2) Bell and spigot pipe with prefitted rubber joints
(3) Conical flanged pipe and fittings
(4) Pipe with cemented-on couplings
(5) Metal flanged pipe
(6) Lined steel pipe
(7) Armored pipe
(8) Screwed joints.

Bell and Spigot Poured Joints

The specifications of one nationally known manufacturer of acid-proof pipe and fittings recommend that when making joints in vertical lines the following procedure should be followed:

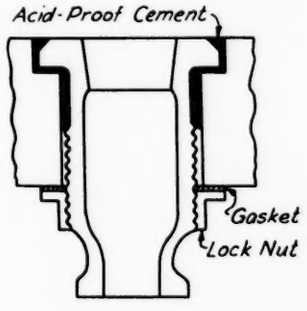


Fig. 5. Special Duriron outlet pipe for tanks.

First tamp one ring of asbestos rope wicking, Fig. 6, tightly into the pipe socket. Then pour hot melted Calktite acid-proof calking compound flush with the top of the hub. The Calktite should be heated in a cast iron vessel over a gas or open fire to a temperature of about 350 to 400F, at which point it will flow freely. Overheating should be avoided and if frothing develops, fresh lumps should be added to cool down the melted compound to the proper pouring temperature.

No topping off material is necessary on vertical joints or when cementing in clean-out plugs.

For making horizontal joints another equally well known manufacturer recommends that two strands of pure asbestos rope wicking be calked into the annular space, instead of one as recommended for vertical lines.

Knight G-K compound should then be poured in until it is within ¼ in. of the top of the hub. On horizontal line, an asbestos runner should be placed tightly around the top of the bell and an opening or gate allowed at the top of the pipe, through which the compound should be poured. The Knight G-K compound flows like water when heated to a temperature of between 350 and 400F. When desired for use in very hot places in the system, such as lines from steam baths, a compound having a very high melting point can be furnished.

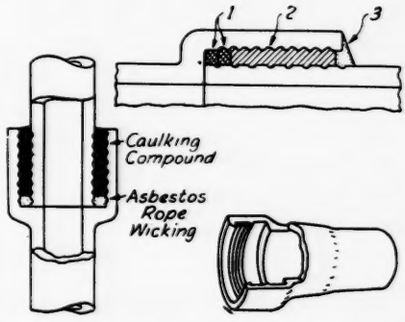


Fig. 6, left. Bell and spigot poured joint. Fig. 7, upper right. Joint for horizontal line consisting of (1) asbestos wicking (2) jointing compound and (3) topping material. Fig. 8, lower right. Bell and spigot pipe with prefabricated rubber joint.

If the horizontal lines are to carry hot solutions, a topping or collar consisting by weight of about 30% ground asbestos, 20% talc and 50% silicate of soda should be used as shown in Fig. 7.

This topping material should be stiff when applied. It will then set up promptly and adhere to the stoneware without trouble. The purpose of this is to keep the compound from running from the joint when subjected to heat. An acid-proof cement, which need only be mixed with silicate of soda and applied, can be furnished for the topping material if so desired.

Asbestos rope wicking should be equal to Johns-Manville No. 4200 using ½ in. rope up to 4 in. size and ¾ in. rope for sizes 5 in. to 8 in. For best results the diameter of the wicking should be about ¼ in. greater than the width of the annular space. Joints made in accordance with the manufacturers' instructions should withstand 20 lb pressure.

Prefabricated Joints

Bell and spigot pipe with prefabricated rubber joints are shown in Fig. 8. With this type of joint, a flexible rubber gasket with multiple sealing edges is cast integrally with the bell end of a specially constructed chemical stoneware bell and spigot pipe.

The Tylox gasket consists of a series of annular rubber wedges tied together with a center web. As the spigot is pushed home, increasing pressure is developed between the pipe and the sealing wedges, inducing true compression throughout the entire joint.

The spigot end of the pipe to be coupled and the gasket should first be lubricated by brushing with Tylox lubricant, and the spigot pushed into the bell, completing the joint.

Standard bell and spigot pipes in horizontal or vertical lines may be coupled in less than 3 minutes per joint without bolts, clamps, or special tools.

The manufacturers claim substantial reductions in installation and maintenance costs with Tylox coupled pipe as well as durability and freedom from leaks for acid handling lines, drains and fume hood ventilation ducts.

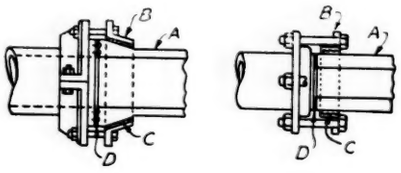


Fig. 9, left. Conical flange joint. Fig. 10, right. Joint with cemented-on coupling.

This type of joint successfully resists corrosion, thermal or mechanical shock, expansion and transverse stress, and remains tight.

Conical Flanged Pipe and Fittings

Conical flanged pipe and fittings, Fig. 9, are recommended for use as follows:

(1) Where the liquids or gases must be handled at a considerable pressure.
(2) On vacuum lines.
(3) Where acid-proof cement or mastic joints can not be considered.

In Fig. 9, gaskets *D* of rubber about 3/16 in. thick, asphalted asbestos, or other suitable material should be inserted between the faces of adjacent sections of pipe. Split cast iron couplings *B* are assembled on the pipe behind the conical flanges with a thin layer of felt, rubber or hemp *C* to serve as a cushion between the pipe *A* and the coupling *B*.

The bolts should be tightened evenly so that the strain or pressure on the pipe flanges will be distributed uniformly.

Pipe with Cemented-on Couplings

A pipe joint with cemented-on couplings is shown in Fig. 10. During the firing of the pipe a permanently rough ring or layer of silica sand *C* is fused into the outer glaze. Portland cement of Vitric-10 acid-proof cement is used to bond this rough layer of fused silica to the undercut metal coupling. The end surfaces of the pipe *A* are ground smooth, flat and square for a gasket *D*.

Four-bolt metal couplings are furnished with all piping up to and including 3 in. ID sizes. For 4 in. ID and larger sizes, eight-bolt metal couplings are used. Angle adaptors are furnished where pipe fittings are to be installed at angles other than that at which bolt holes will match. All metal parts are protected by Tygon corrosion resistant paint.

Knight-Ware Metal Flanged Pipe

This joint, Fig. 11, is made by slipping standard metal flanges loosely on the pipe and forming raised shoulders near the ends of the pipe with Permanite cement. This material adheres firmly and is very tough, making a bearing against which the flanges pull when bolting the pipe together. The flanges being loose are self-aligning, which eliminates danger of fracturing the pipe when bolting together. A gasket is inserted between the ends of the pipe before making up the joint.

Lined Steel Pipe

In Fig. 12 is shown the joint used with Knight-Ware lined steel pipe. Pipe of this type, of standard bores, is made to fit available standard steel or fabricated pipe allowing ¼ in. to ⅜ in. thickness of Pyroflex.

Plain ground-end liner pipe is floated and firmly held inside the steel pipe with a continuous sealing of Pyroflex. The ends of the liners project beyond the faces of the metal flanges which are attached to the steel pipe in the usual manner. A gasket is inserted between the faces of adjacent sections of pipe before tightening the bolts. This type of joint is used where the pipe may be exposed to physical damage, high pressures or thermal shock.

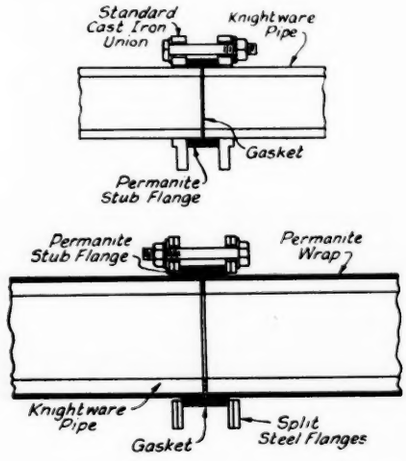


Fig. 11, upper. Metal flange joint for Knight-Ware. Fig. 12, lower. Joint used with Knight-Ware lined steel pipe.

Pipe Joints for Armored Pipe

The joint used with Permanite Armored Knight-Ware pipe is of the positive compression seal type and is designed to handle hot or cold corrosive liquors under pressure. The ends have a Permanite impregnated glass fabric collar bonded to the Permanite covering. The ends of the chemical tile pipe are faced smooth with Permanite collars. Split steel flanges are fitted behind these collars and a ring type gasket is

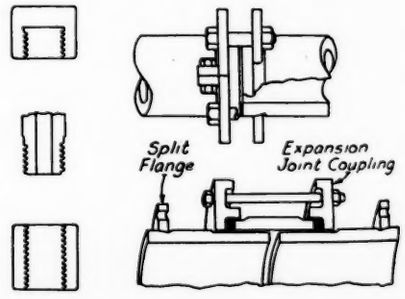


Fig. 13, left. Parts of threaded sleeve connection for synthetic resin pipe. Fig. 14, upper right. Split flange joint. Fig. 15, lower right. Expansion joint.

used to seal the joint between the two butt ends of the pipe.

The advantages of this type of construction are:

(1) Ability to withstand physical and thermal shock.
(2) Acid-proof construction both inside and out.
(3) Light weight as compared with rubber lined steel pipe.
(4) Field assembly requires minimum labor, and pieces can be cut and assembled in the field.

Screwed joints are also used in some cases where a threaded end on a cock can be screwed into a softer substance.

SYNTHETIC RESIN PIPE

Pipe of this type is molded from a mixture of special acid-digested asbestos and a synthetic phenol-formaldehyde resin.

This material, which is manufactured under the trade name Haveg, has strength, toughness and durability together with excellent corrosion resistance and can be cut with a hack saw, turned in a lathe, drilled, tapped, milled and otherwise machined in practically the same manner as metals.

The pipe may be threaded and coupled together as shown in Fig. 13. In chasing or tapping threads in Haveg, allowance should be made for the fact that the

Fig. 16. Joints for Haveg fume duct—sizes 2-12 in., left; 14-30 in., right.

thread strength is considerably lower than with metals. While it is possible to machine Haveg with U.S.S. and taper threads, 29° Acme threads are stronger, and are therefore recommended wherever practicable.

While common tool steel may be used for machinery operations on Haveg, it will dull rapidly. For threading, special tipped tools which can be used 50 to 100 times longer between grindings than ordinary tool steel, are preferable.

Dull tools should not be used as poor finish, inaccurate work and broken threads will result.

Split Flanged Joints

Tapered grooves, Fig. 14, may be machined near the pipe ends and split flanges bolted together using a composition or rubber gasket between the pipe ends.

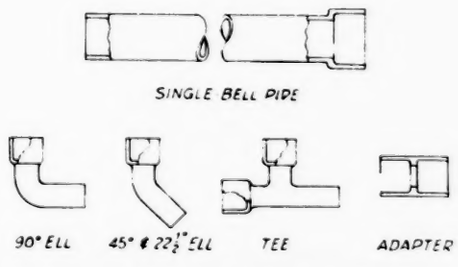


Fig. 17. Bell and spigot fittings for Haveg fume duct.

Expansion Joints

The use of expansion joints, Fig. 15, is recommended on all lines which are not free to move lengthwise. This type joint is also widely employed for general

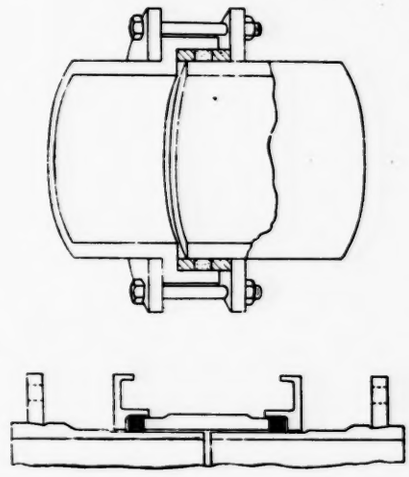


Fig. 18, upper. Bell and spigot expansion joint for standard fume duct. Fig. 19, lower. Expansion joint for Haveg fume duct.

use in lines which may be subjected to bending, distortion or vibration.

Joints for Fume Duct

There are three general methods of making joints for Haveg fume duct. The split flange method is most widely used, and for sizes up to and including 12 in. diameter, is the same as for Haveg pipe.

For sizes 14 in. and larger a split angle ring flange is used as shown in Fig. 16. In these sizes the pipe is reinforced at the joint by means of an internal rim.

Bell and spigot joints are also used with fittings as shown in Fig. 17. A bell and spigot expansion joint for standard fume duct is shown in Fig. 18.

The expansion joint method for connecting Haveg fume duct is shown in Fig. 19. For this joint the fume duct is supplied with plain ends machined on the O.D. This type of joint is widely employed where prefabrication is not possible and fitting on the job is necessary. Standard lengths are readily cut and the O.D. lathe-turned on the job.

PLASTIC TUBE AND PIPING

Saran tubing, which is made from thermoplastic resin, is furnished with flared fittings similar to those used for thin wall tube but injection molded of Saran. The fittings are available in sizes to match the standard Saran tube diameter from $\frac{1}{8}$ to $\frac{3}{4}$ in. Parker standard tube fittings, S.A.E. and other flare type fittings may also be used with Saran tubing.

It is both unnecessary and undesirable to make up joints too tightly on such tubes for the material is resilient and forms its own seat without great pressure. Care should be taken when metal fittings are used with Saran tube not to make up too tightly for the flare may cut or flow.

Molded Saran fittings may be made leak and vibration tight by turning-up hand tight plus an added approximate quarter turn with a wrench or pliers.

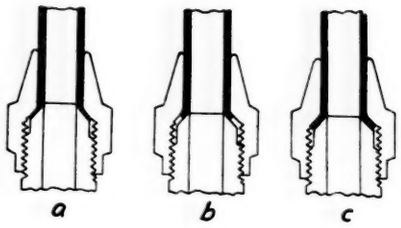


Fig. 20. Examples of flared joints—a and b, incorrectly flared; c, correctly flared.

If automatic wrenches are used, they can be set using the following table as a guide.

O.D. of Tube, Inch	Thickness, Inch	Torque Required, In. Lb.
¼	.031	6
	.045	11
	.062	16
⅜	.031	11
	.062	33
½	.045	45
	.062	50
¾	.062	95

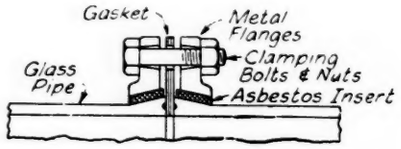


Fig. 21. Joint for Pyrex glass piping.

When making flared joints, it is essential that the end of the tubing should be cut square and the end correctly flared.

Use of a special clamp and flaring tool furnished by the manufacturers is advisable. The operation should be carried out at room temperature or above. If the temperature is below 50F, the tube and the flaring tool should be warmed by dipping in warm water.

In Fig. 20 is illustrated at *a* a flared joint that is too thin because it has been squeezed and the joint weakened; *b* a flared joint that is too short, probably because the tube slipped in the clamp, and which is likely to pull out; *c* a flared joint in which the length and thickness of the flare are correct.

This joint will provide maximum resistance to vibration and pull-out.

Saran piping is produced by a modified extrusion process which assures a smooth, round product having dimensions similar to those of extra heavy iron pipe. It is at present available in sizes from ½ in. to 4 in. I.P.S.

Screwed, flanged and welded joints may be used. For making screwed joints Saran pipe can be threaded with standard pipe threading tools, either hand or power driven, with only two minor changes as follows:

(1) Because Saran pipe is less rigid than metal pipe, a longer guide sleeve is desirable for proper centering.

(2) In order to produce clean, sharp threads, cutting tools should be ground to produce a front rake angle of 5° to 10°.

In other respects the operation is similar to that for cutting of standard pipe threads on metallic pipe.

Best results are obtained when operating between 50 and 100F. At lower temperatures, heated dies are beneficial. A lubricant is advisable but its use is not essential.

The use of pipe dope is recommended when making up screwed joints. Graphite lubricating dope will facilitate taking the joint apart later. Screwed flanges of the same material may be used when desired.

Welding operations with Saran pipe are both simple and rapid. For hot plate welding, a heated plate having a smooth nickel or chromium surface is preferred. The two pieces to be welded are placed on a hot plate maintained at a temperature of 400 to 500F and are held long enough to form a small inventory of molten material. The bead of molten material is visible at the outside surfaces of the two pieces. The pieces are then removed from the hot plate, placed together in the desired position, pressed together firmly and allowed to cool. Time required for cooling is about 10 seconds. The entire operation is completed in about 45 seconds. The initial set allows complete freedom from handling, but full strength in the joint is developed after 24 hours. This permits crystallization of the material to take place and makes the joint strength equal to that of the pipe itself.

Final joints of pipe can be welded in position after erection. A special hand held hot plate furnished by

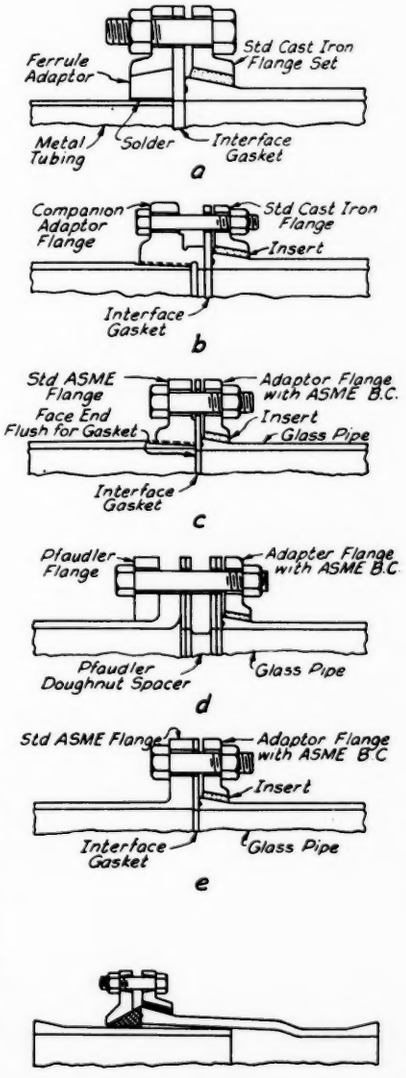


Fig. 22. Adaptor connections for a, metal tubing; b, cast iron adaptor flange; c, ASME screwed flange; d, Pfaudler enamel-lined piping; e, ASME flanged fitting. Fig. 23, bottom. Expansion joint for glass pipe

the manufacturers provides a convenient, easily controlled tool for field welding.

GLASS PIPE

Fig. 21 illustrates a typical flanged joint for use with Pyrex glass piping.

A conical flange is formed on the end of the pipe and a metal flange is slipped over the end of the pipe. The opening in the flange is conical in shape, with the opening at the small end just large enough to slip over the enlarged conical end of the pipe. An asbestos insert strip is then wrapped around the conical flange on the glass pipe to provide a bearing surface and to hold the metal flange in place.

An interface gasket of material specified by the purchaser is inserted between the ends of the pipe. After carefully checking to insure that the gaskets are lined up with the pipe's inner surface so that no part protrudes into the pipe to obstruct flow or cause a liquid pocket, the bolts should be pulled up evenly all around till the metal flange face is nearly flush with the end surface of the insert. This will leave the glass pipe end projecting slightly.

Care should be exercised to keep the interface gaskets dry throughout the installation work. If rubber gaskets are installed wet, they may slip out between the flanges on sudden application of line pressure. Gaskets will blow out it the pipes are not properly aligned or if the piping is supported so loosely that fluid movement in the lines causes it to be momentarily moved out of alignment at the bends.

Occasionally a pipe line will begin to leak at the joints after it has been in service for a short time. This is because the asbestos inserts gradually seat themselves more snugly around the conical flanges, permitting the iron flanges to rest slightly nearer the pipe ends. Retightening the bolts at the leaky joints will correct this permanently. Even if no leaky joints are discovered, it is advisable to go over all joints about one or two days after they are made to take up slack from gasket compression, insert movement, etc.

For milk lines it is specially important to keep flange bolts tightened during the first few weeks of operation. If the joints are not tight, milk will seep between the gasket and the glass pipe end and this is not a sanitary condition.

Adaptor connections for connecting to steel, cast iron, lead, stainless steel, porcelain, hard rubber and rubber lined metal provide a satisfactory and simple means for connecting glass piping to any pipe line, valve or equipment. Fig. 22 shows adaptor connections for:

(a) Connection to metal tubing
(b) Connection to cast iron companion adaptor flange
(c) Connection to ASME screwed flange
(d) Connection to Pfaudler enamel-lined piping
(e) Connection to ASME flanged fitting

An expansion joint for use with glass pipe is shown in Fig. 23.

Bell and spigot pipe joints are also widely used in diameters up to 18 in. where conveyance of liquids or gases at low pressures requires a combination of chemical resistance and thermal ruggedness.

References

For additional information on these joints the reader should refer to bulletins of the following manufacturers:

The Duriron Co., Dayton, Ohio.

The U. S. Stoneware Co., 5300 E. Tallmadge Ave., Akron, Ohio.

Maurice A. Knight, 171 Kelly Ave., Akron, Ohio.

Universal Sewer Pipe Corporation, 1500 Union Commerce Bldg., Cleveland, Ohio.

Haveg Corp., Newark, Del.

The Dow Chemical Co., Midland, Mich.

The Corning Glass Works, Corning, N. Y.

Reference should be made to the following text books:

Gray, Wm. Beall and Ball, Charles B., *Plumbing*, Chicago American Technical Society, 1919.

Parthington, E. B., *Chemical Plumbing, Leadburning and Oxy-Acetylene Welding*, The British Oxygen Co., Ltd., London, England.

Foul Air from a Ventilating System

An air conditioned establishment with a ventilating system, which had given several years of satisfactory service, suddenly exuded an odor characteristic of an over-ripe rodent. The entire supply duct system had been carefully examined by the operating force and no indication of either defunct flora or fauna had been discovered.

A suggestion was made to the management that, since the duct system was apparently exonerated and since, according to observations, the source of the odor was not outside the building, it would be well to examine the fresh air intake, from the louvers in the outside wall of the building, to the fan inlet. The trouble was found and remedied within an hour.

What had actually happened was that the apparatus had not been in operation for several days and, just prior to the inoperative period, there had been a driving rain storm. The water had beaten in through the louver and had flooded the intake chamber at the base of the vertical shaft. The subsequent period of inactivity had allowed this water to lie stagnant, with no air circulation to evaporate it.

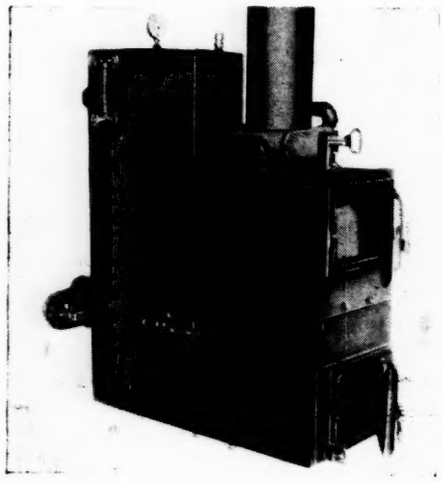
MORAL: Make adequate provisions for automatically draining the chamber at the base of the fresh air intake, even if it does add a dollar or two to the contract price. It will cost considerably more if it has to be done later, and surely the good will of the client is worth a little trouble to retain.—*John J. Woolfenden, Engineering Staff, Smith, Hinchman & Grylls, Inc., Detroit, Mich.*

NEWS OF EQUIPMENT AND MATERIALS

Combination Boiler

NAME—Diesel-American oil or coal burning unit.

PURPOSE—Space heating by means of a boiler which can burn oil or coal.



FEATURES—Two separate combustion chambers, one for coal and one for oil, are combined in a compact jacket. A manual damper with electric control switch is used in changing over from one fuel to the other. It automatically shuts off one unit when converting to the other fuel. The coal furnace has a full size fire box on grates that will contain sufficient coal for about 8 hours operation. A diaphragm draft control with counter balance is provided to regulate the burning of coal. Boiler is constructed of ¼ in. plate steel with baffles of the same size steel. A 10 in. steam chamber is provided. It has 8 2-in. outlets for circulation and cleaning purposes, and a 2½ in. outlet for low water cut-off. The cut-off shuts off the oil burner or rings an alarm bell when the unit is fired by coal and the water drops to a low level. A diaphragm checks drafts on burner upon rising steam pressure to reduce flame to normal operation. A DA-0 Diesel-American gun type oil burner is mounted on a flange to the boiler. Combustion chamber for this burner is of refractory material. Tankless coil is used for supplying domestic hot water. Boiler is covered with a 2 in. insulating blanket and enclosed in a steel casing.

SIZES AND CAPACITIES—In sizes for 350, 450, 550, 850, 1,000 and 1,400 sq ft steam radiation.

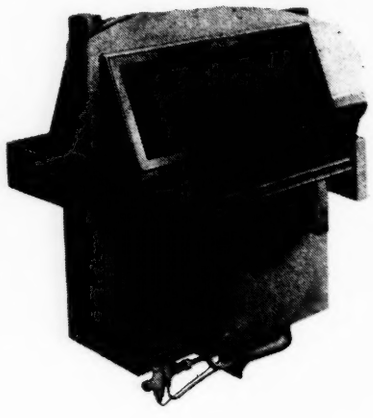
MADE BY—*Diesel Oil Burner Corp., 105-20 New York Blvd., Jamaica, N. Y.* **194**

Floor Furnace

NAME—Fraser & Johnston Model 35 DW floor furnace.

PURPOSE—Space heating.

FEATURES—Furnace is made of heavy pressed steel construction with a seam-welded heating element. Design permits interchangeability of parts of two models. Unit has a single rod control valve for both manual and automatic operating controls and where natural, manufactured, or low pressure gas is used. Unit is 26½ in. deep



over-all from top of floor to lowest part of furnace.

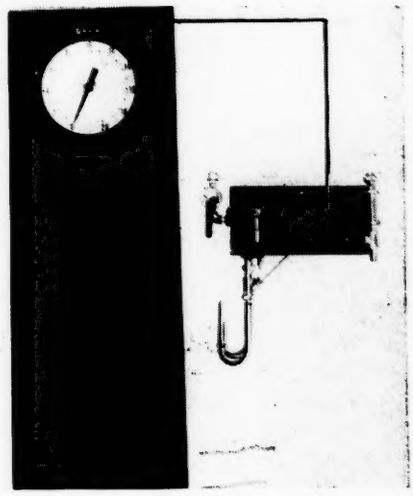
MADE BY—*Fraser & Johnston Co., 725 Potero Ave., San Francisco, Calif.* **195**

Gas Analyzer

NAME—Davis flue gas analyzer.

PURPOSE — For continuously indicating and recording stack gases as a guide to more efficient combustion.

FEATURES—Unit analyzes the composite of stack gases and gives a continued indication of the completeness of combustion. It shows if too much air or insufficient air is provided. Unit consists of a recorder and panel 2 ft wide by 6½ ft high, and a flow panel mounted near or at the point of sampling. It is electrically operated from 110 volt, 60-cycle power source and uses a Wheatstone



Bridge and a stainless steel analysis cell for measuring thermal conductivity of the composite stack gases. The differential pressure in the stack is used to cause an ample and continuous flow of stack gases through the analysis cell thereby eliminating moving parts. Analysis cell operates on a "wet gas" basis doing away with the need for a chemical drying chain.

MADE BY — *Davis Emergency Equipment Co., Instrument Division, 45 Halleck Street, Newark 4, N. J.* **196**

Insulating Block

NAME—Kaylo heat insulating block.

PURPOSE—Heat insulation.

FEATURES—Compound, available in brick form, weighs 11 lb per cu ft and can be used for temperatures up to 1200F. Tests have shown that efficiency improves after exposure to service temperatures. Material can be sawed, cut, and scored with common woodworking tools.

LITERATURE AVAILABLE—Illustrated folder.

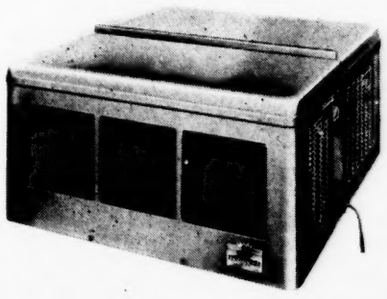
MADE BY — *American Structural Products Co., subsidiary of Owens-Illinois Glass Company, Toledo 1, Ohio*.....**197**

Room Conditioner

NAME — Frigidaire window-type room air conditioner.

PURPOSE—For cooling homes or offices.

FEATURES—Dual refrigerating systems operated by two hermetically-sealed, self-oiling Meter-Miser compressors provide more than 0.75 ton refrigerating capacity. They can be operated together or separately according to outside temperature. One of the systems is capable of supplying adequate cooling for the night hours and temperate summer weather. Two controls regulate the conditioning. A four-position switch controls the fan and cooling systems and an adjustable fresh air control governs the amount of outside air brought into the unit. A thermostat control can provide automatic operation of one refrigerating system. Cooling and condensing fans are powered by a 1/6 hp motor. Unit is provided with a spun-glass filter.



SIZES AND CAPACITIES—Unit measures 28¼ in. wide, 32⅛ in. deep, 14¼ in. high, and can condition rooms up to 500 sq ft in size. It cools and circulates air at the rate of 325 cfm. Outside air can be added at the rate of 50 cfm.

MADE BY—*Frigidaire Div., General Motors Corp., Dayton 1, Ohio*...**198**

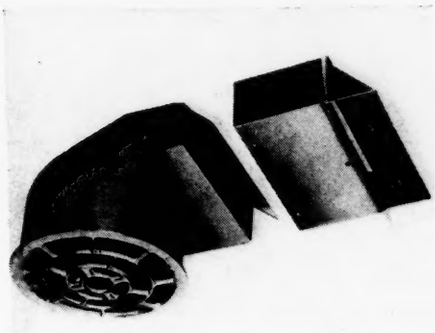
Ceiling Fan

NAME—Shepler radia ceiling ventilating fan, model 81.

PURPOSE — Designed for installation over cooking ranges where wall space is limited for wall type fans.

FEATURES — Louver, of 20-gage steel, is mounted in the end of the fan housing; another louver is mounted on the outside wall hood. Both open automatically when the fan is turned on and close by gravity when the fan is not operating. Louvers are mounted on sponge rubber seats. Ceiling unit is connected to the outside wall vent unit by a galvanized duct which can be made any length or shape to suit the installation. Once installed, only the aluminum grille in ceiling is visible. Fan has a 10-in. blade and Redmond motor is operated by a 110-120 volt, 50 to 60 cycle unit.

SIZES AND CAPACITIES — Rating is 650 cfm free air delivery.



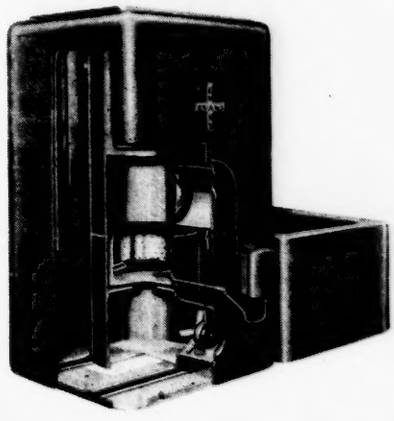
MADE BY—*Shepler Manufacturing Co., 1325 Sheffield St., Pittsburgh 12, Pa.* **199**

Winter Air-Conditioner

NAME—Oil-fired, all-purpose furnace, Model 388.

PURPOSE—Space heating unit for average size home, using fuel oil.

FEATURES — Unit available with blower underneath, either side or at rear of furnace for installation in furnace closet, basement, recreation rooms or utility room. Standard equipment includes room thermostat, all wiring and humidifier. A squirrel cage type blower circulates heated and filtered air in winter; provides cooling in summer. Burns No. 1 fuel oil.



SIZES AND CAPACITIES—Floor space, blower at side or rear: 33½ x 56 in. Casing height, blower at side or rear: 55 in. Floor space blower underneath: 28 x 33½ in. Casing size, blower underneath: 76 in. Bonnet output, 82,500 Btu per hr.

MADE BY—*Evans Products Co., Heating and Appliance Div., Plymouth, Mich.* **200**

Boiler

NAME—York-Heat PB7-R boiler.

PURPOSE—Boiler designed to supply the low-temperature water required for radiant heating or the high-temperature water for domestic use.

FEATURES—Unit has a lower, outer jacket and an upper boiler section. Low-temperature water for the radiant heating coils is tapped from the cooler outer jacket while the hotter upper section supplies high-temperature domestic hot water by means of a long, instantaneous heating coil. Connections permit free circulation of water from the heater to the inner boiler section. A circular baffle arrangement directs the hot combustion gases through long, narrow circular passages between the inner and outer shell wall for maximum heat transfer. An air chamber is located in the top of the boiler to accumulate air released from the water and to provide a cushion for expansion of the water.

SIZES AND CAPACITIES—Made in two sizes for maximum heat output of 81,000 and 110,000 Btu per hr. Domestic hot water capacity is 3 gal. per min. in both models.

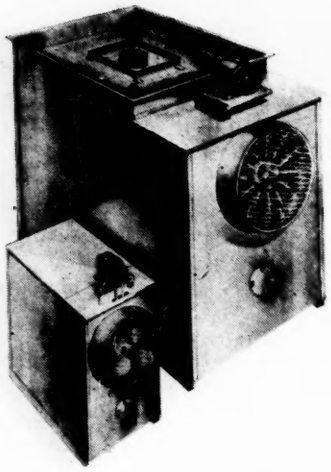
MADE BY—*Residential Division, York-Shipley, Inc., York, Pa.*.....**201**

Cooling Tower

NAME—Aquatower.

PURPOSE — Packaged - type water cooling tower.

FEATURES—Unit has all steel integral welded casing with redwood



filling. Fans are aluminum and basins are made of steel. Large towers have open distribution system with splash box while small ones have removable covers with threaded inlet pipe at rear of distribution basin. Electric motors are 3-phase, 60-cycle, 220 or 440 volts. Those of less than 1 hp are totally enclosed; larger size is splashproof motor. Basin is integral with the tower casing and all basin piping and fixtures are placed at the rear of tower for easy access. Unit is engineered for indoor or outdoor operation

SIZES AND CAPACITES—Two general styles and seven sizes ranging from 3 to 50 tons of refrigeration.

LITERATURE AVAILABLE — Bulletin AC-48.

MADE BY—*The Marley Co., Inc., Kansas City 15, Kans.* 202

Thermostat

NAME — Minneapolis - Honeywell plug-in thermostat.

PURPOSE—Automatically controlled thermostats to replace manually set thermostats.

FEATURES—Unit is a modification of the company's Chronotherm but uses a 110-volt clock motor instead of the 24-volt motor. Unit comes

equipped with a universal wall plate to facilitate electrical connections with existing thermostat wires. Makers claim that design of the wall plate will make it applicable to almost all types of existing thermostat mountings made by Honeywell and other manufacturers of automatic heating controls. By connecting the 110-volt motor to a utility outlet, use of a transformer in the basement is avoided as well as the need for running a 5-wire cable through the walls to the thermostat location.

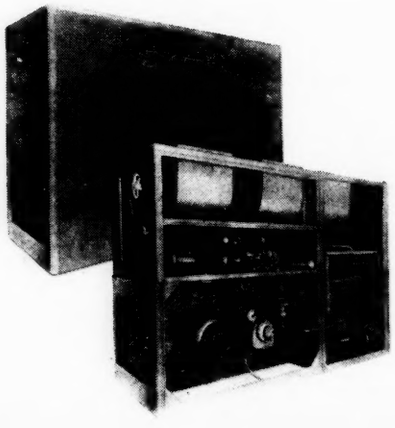
MADE BY—*Minneapolis - Honeywell Regulator Company, Minneapolis, Minn.* 203

Air Conditioner

NAME—Refrigerated Kooler-aire.

PURPOSE—Packaged central station air conditioning unit.

FEATURES—Factory-engineered, assembled and tested, the unit is a central station packaged job that cools, dehumidifies, filters and ventilates. The three-in-one unit houses the refrigeration compressor section, and the evaporative condenser section. Cooling coils have been increased in depth for greater capacity. Cabinets are insulated with glass fiber. Unit can be shipped in separate sections where small entrances prohibit handling of the entire packaged unit. Once in place, only three connections are required with electrical system, duct system, and water supply and drain.



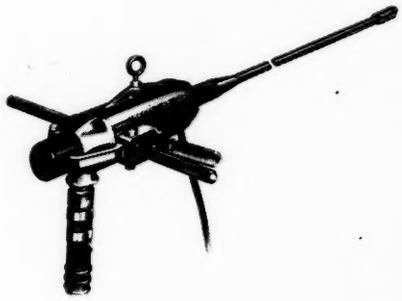
SIZES AND CAPACITIES—Available in nine sizes, ranging from 3 to 40 ton refrigeration.

MADE BY—*United States Air Conditioning Corp., Minneapolis 14, Minn.* 204

Tube Cleaner

NAME—Airetool direct-drive cleaner, model CC-450.

PURPOSE—For cleaning scale conditions from condenser and heat exchanger tubes.



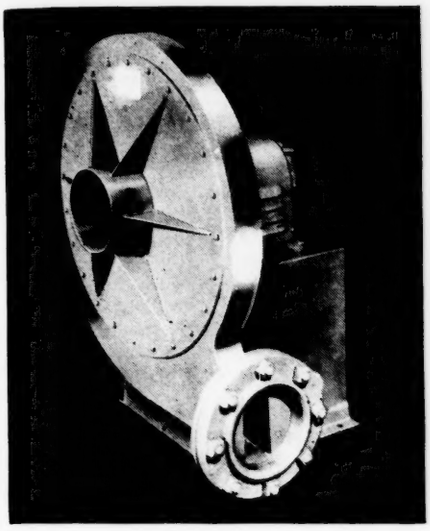
FEATURES—All moving parts are made from alloy steel and the outer case is of light-weight aluminum alloy. A handle valve provides the operator with a positive control. The direct drive, high speed motor is air or steam driven. The flushing agent is introduced through the motor and the drive shaft to the cutting edges to insure a cool drill and to flush out the removed deposit. The packing glands prevent leakage of the flushing agents. Various designs of cutters and drills are available for use with this unit.

SIZES AND CAPACITIES—For cleaning tubes from ⅜ to 1½ in. I.D.

MADE BY—*The Airetool Manufacturing Co., Springfield, Ohio*.....205

Centrifugal Blower

NAME—National centrifugal blower—Type NC.
PURPOSE—To furnish air at high pressures for use with oil and gas burners on industrial furnaces.



FEATURES—Blower has flange discharge complete with a companion flange which permits direct attachment to combustion equipment, eliminating need for couplings or unions. Front plate of blower is reinforced with triangular gusset plates, eliminating transmissional vibration and breathing. This is said to reduce the noise level and to make for quiet operation of both single and multi-stage blowers. Construction throughout is 3/16 in. welded plate.
SIZES AND CAPACITIES—Furnished in sizes to deliver varying volumes of air, ranging from 80 to 6,000 cfm, at pressures from 4 oz to 2 lb.
MADE BY—*Combustion Systems, Div. of Vapofier Corporation, Chicago, Ill.* **206**

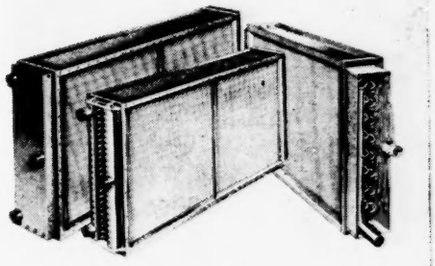
Water Heater

NAME—Crescent side arm water heater.
PURPOSE—Heating domestic water.
FEATURES—A snap-action thermostat controls water temperature in the heater and in the tank. Finger tip control of the thermostat permits pre-setting of any desired temperature. A thermo-magnetic safety pilot will shut off both the main burner and pilot should the pilot flame be extinguished. All controls are placed on front of the heater for easy adjustment. The integral valve casting is a combination of a snap-action thermostat, safety pilot, main gas cock, main gas flow control valve, and pilot flow control valve. Adjustment of the maximum gas for both main burner and pilot can be made to simplify lighting procedure. Heater is equipped with side panels that can be removed to expose the coils to their full length on two sides for inspection and cleaning. Fiber glass insulation is used in the jacket. Copper coils and fittings are used.

SIZES AND CAPACITIES — Input of 20,000 Btu for natural gas or 22,000 Btu for manufactured gas, and a selective temperature range of 40 to 180F. Model for liquefied petroleum with input of 20,000 Btu per hr also available.
MADE BY—*E. L. Mustee and Sons, Inc., 6911 Lorain Ave., Cleveland 2, Ohio*.....**207**

Cooling Coils

NAME—Modine cooling coils.
PURPOSE — Coils for heat transfer.
FEATURES—A wide choice of types, styles, models and sizes for cooling are available in a new line of Modine coils. Coils for use with chilled water are provided in Standard and Cleanade styles in a total of 24 models and five casing widths and 17 casting lengths. Direct expansion type coils are supplied in four models and in the same casing dimensions.
LITERATURE AVAILABLE — Catalog 448. Section One covers descriptive information on water and direct expansion type. Section Two provides physical and technical performance data on cooling coils; Section Three will be available shortly to present technical data on direct expansion coils.
MADE BY — *Modine Manufacturing Co., Racine, Wis.* **208**



Floor Furnace

NAME—Ward floor furnace.
PURPOSE—Space heating.
FEATURES—Unit comes as a complete package ready to connect to gas lines. Models are available for natural, manufactured, LP or mixed gases. Unit has a built-in thermal control with by-pass feature and a safety pilot which shuts off gas flow if flame should go out. Both inner and outer shells are made of heavy, galvanized iron, insulated with asbestos. A gas shut-off cock, set a few inches under the floor for easy accessibility, is standard equipment. Burner assembly is removable as a complete unit by unscrewing four wing nuts. Brass screw cap on the lighter door, which expands when heated, hermetically seals the heating chamber to guard against the escape of combustion gases into the home. Burned gases and moisture are vented to the outdoors.
MADE BY — *Ward Heater Co., Los Angeles 15, Calif.* **209**

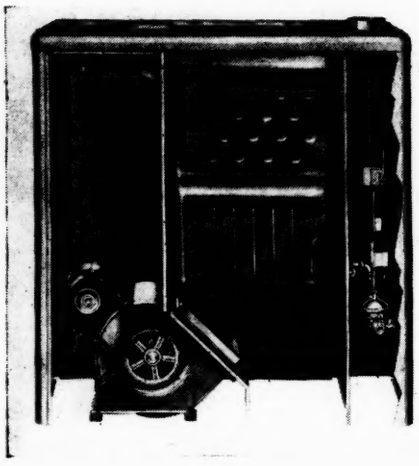
Air Conditioner

NAME—American Thermal packaged air conditioner.
PURPOSE—Air conditioning.

FEATURES—In addition to the units, which are powered by Servel, units incorporate features found in the conventional Ameritherm machines. Units are completely equipped at the factory and panels may be removed for servicing.
SIZES AND CAPACITIES—3, 5, 7½, 10 and 15 ton.
MADE BY—*American Thermal Industries, Inc., 440 Illinois Ave., Detroit 1, Mich.* **210**

Furnace

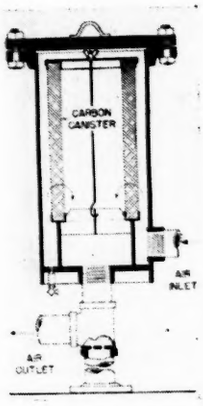
NAME—Payne Zoneair model ZAU.
PURPOSE—Forced warm air heating for use with natural, manufactured or liquefied petroleum gas.
FEATURES — Heating element sections are die-formed from cold rolled steel in a streamlined design. Vertical flue gas travel is said to prevent trapping of unburned gases or corrosion - producing condensates. Slotted port type design burners are claimed to operate without the customary burner roar. A stainless steel cross-ignition burner insures positive lighting of all main burners from the pilot flame. The blower is mounted on vibration insulators to eliminate mechanical noises. A variable motor sheave permits adjustment of delivery of blower air. Controls are enclosed in the casing front vestibule and consist of safety pilot, transformer and fan and limit controls with summer ventilating switch.



SIZES AND CAPACITIES—Four sizes, ranging from 67,000 to 167,000 Btu per hr input rating.
LITERATURE AVAILABLE—Illustrated folder.
MADE BY — *Payne Furnace Co., Beverly Hills, Calif.* **211**

Gas Adsorber

NAME—Dorex type PL gas adsorber.
PURPOSE — To extract odors and gaseous impurities from compressed air.
FEATURES—A removable adsorption canister is housed in a flanged steel shell containing internal manifold, air inlet, outlet and drain connection. The makers claim that the activated carbon adsorption medium often lasts several years before requiring replacement. Replacements can be made without breaking pipe connections.



LITERATURE AVAILABLE — Bulletin 113-A.
MADE BY—*W. B. Connor Engineering Corp., 114 E. 32nd St., New York 16, N. Y.* **212**

Motor Starter

NAME—Penn magnetic motor starter and contactor.
PURPOSE—For the starting and stopping of motors.
FEATURES—Unit has an over-load relay which is adjustable for manual and for automatic reset. To convert from one operation to the other it is only necessary to change the position of the reset spring. Steel-backed silver contacts are spot welded to assure long life for the contact points. Solenoid coils for all commercial voltages and frequencies are interchangeable in this starter. Overload relay is completely enclosed in a bakelite case to prevent tampering. One

such relay is supplied with 2-pole starters; two with 3- and 4-pole starters.
SIZES AND CAPACITIES—Size 0 and 1 starters and contactors are available in 2-, 3- and 4-pole construction.
LITERATURE AVAILABLE — Bulletin 2705.
MADE BY — *Penn Electric Switch Co., Goshen, Ind.* **213**

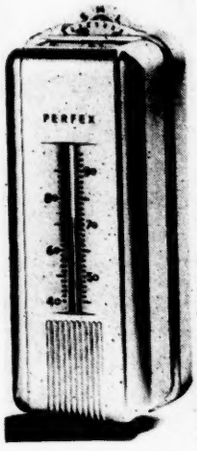
Electric Radiator

NAME—Hurseal radiator.
PURPOSE—Radiator heated by electric power.
FEATURES—Built of light pressed steel, unit is loaded with a low expansion oil and hermetically sealed. Each type has its own designed electric heater. Because of the sealed-in oil in place of water, makers claim that no air vent is necessary.

Heating is dispersed over a radiating surface of 20.15 sq ft per kw.
MADE BY—*Hurseal Co. of America, 214 E. 41st St., New York 17, N. Y.* **214**

Room Thermostat

NAME — Perfex magic dial room thermostat, series 165.



PURPOSE—Thermostatic control for gas, oil or coal-fired heating systems.

FEATURES—Unit permits precise adjustment of the on-off cycling of the burner, from a short to a long "on heat" period. Fully enclosed twin contact switch protects against the accumulation of dust and accidental damage. Wires terminate at plate to which the thermostat is mounted with two screws. Dial type temperature adjustment is located at the top of thermostat.

MADE BY—*Perfex Corporation, Milwaukee, Wis.* **215**

Check Valve

NAME—AMP check valve.

PURPOSE—Control of liquids or gases.

FEATURES—Valve includes a large seat area, soft rubber washer, and a self-washing seat that the makers claim assures positive closure. Valves are approximately 2 in. in over-all length and are tested for leaks on assembly against 50-lb pressure.

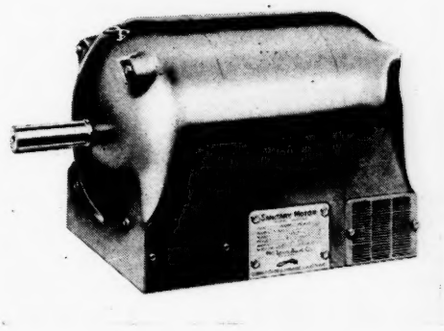
MADE BY—*AMP Corporation, 2921 Locust St., St. Louis, Mo.*.....**216**

Motor

NAME—Allis sanitary motor.

PURPOSE—Enclosed motor for use in dairies and food process plants.

FEATURES — Motor is streamlined and free from cracks, recesses or depressions where food products might collect. The entire motor base is enclosed by the motor housing to keep out foreign particles. Mounting bolt holes are located in accordance with NEMA standards so that there can be complete interchangeability with motors now in use. Access to mounting bolts is through removable grille plates.



Motor can be operated in wet or humid locations or washed down with a pressure hose. Single end ventilated by two fans in series. Motor is supplied with type C flange for pump application.

LITERATURE AVAILABLE — Bulletin No. 711.

SIZES AND CAPACITIES—½ to 25 hp.

MADE BY—*The Louis Allis Co., Milwaukee 7, Wis.* **217**

Floor Furnace

NAME—Oran oil burning floor furnace.

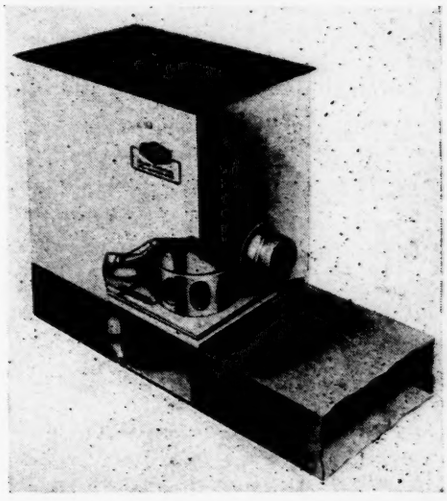
PURPOSE—Space heating.

FEATURES — Complete assembly of burner controls and valves can be lifted out for servicing at the floor. A low draft burner is said to assure clean and efficient operation at all burning stages. Combustion chamber and heat exchanger are connected by a flue that is welded air tight to both units. An auxiliary cold air return has a provision for an independent duct-return of cold air from any area. By removal of plate at bottom of heat exchanger a cold air duct can be run to any desired area to take care of rooms that are normally hard to heat. Valve baffle of aluminized steel shields control valve from combustion chamber heat. Outer walls of liner, when assembled to casing, form cold air return passages around all four walls of casing and liner to give maximum warm air output.

LITERATURE AVAILABLE—Illustrated folder.

SIZES AND CAPACITIES—50,000 Btu output.

MADE BY—*The Oran Co., 2232 S. Third St., Columbus, Ohio*.....**218**



JULY, 1948

TO OBTAIN FURTHER INFORMATION ON NEW EQUIPMENT

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Abstracts AND Reviews

FAN ENGINEERING

To every engineer concerned with air handling, the appearance of a new edition of "Fan Engineering" is an event, and this is especially true of the 5th edition, now available. The 4th edition, in 1938, had 739 pages, the new 5th edition, 808 pages. The book has been rewritten and reset under the capable direction of the editor, Richard D. Madison.

The book consists of five main parts: (1) Physics of Air (204 pages); (2) Fans (140 pages); (3) Fan Applications (267 pages); (4) Fans and Air Conditioning Equipment (141 pages), plus nearly 50 pages of miscellaneous material and a complete index.

The section titles, however, do not do full justice to the scope of the subject matter covered. This is particularly true of the third section (Fan Applications) which includes heating, ventilating, humidifying and dehumidifying, cooling, drying, combustion, air cleaning, exhausting and conveying.

In spite of the almost 10% increase in pages, the 5th edition is hardly appreciably thicker than the previous edition, and thus has well maintained its exceptionally convenient size. The typography is, as before, excellent, and is most readable as well as attractive. This book is a must for the library of every heating, ventilating, and air conditioning engineer.

Fan Engineering, edited by Richard D. Madison. Bound in black fabrikoid, 4¼ in. x 6⅞ in., 808 pages. Published by Buffalo Forge Co., Buffalo, N. Y. Price, $6.00.

VENTILATION AND AIR CONDITIONING

A perspective of ventilation and air conditioning based on British practice is presented in the second edition of this book by E. L. Joselin, formerly lecturer in heating and ventilation, Borough Polytechnic, London. Written to meet the needs of the student and ventilating engineer, the first edition has been revised to include an expanded chapter on air conditioning. A chapter has been added on refrigeration and revisions have been made in the chapter on Flow of Air in Ducts.

Some of the chapters cover atmospheric air; standards of ventilation; natural ventilation; mechanical ventilation; flow of air through ducts; design of air ducts; fans; fan testing and calculations; ventilation combined with heating; air purification; air conditioning; refrigeration for air conditioning.

Included are folded charts on friction of air in ducts, and a psychrometric chart plotted from data abstracted from the Callendar Steam Tables and humidity tables of the Institution of Heating and Ventilating Engineers.

Ventilation and Air Conditioning, by E. L. Joselin. Cloth bound, 5½ x 8½ in., 320 pages. Published in England. Available through Longmans, Green & Co., 55 5th Ave., New York, N. Y. Price, $5.50.

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INDUSTRIAL HYGIENE NEWSLETTER—Monthly publication of articles and news items concerning industrial hygiene, issued monthly by the Federal Security Agency, Public Health Service, Washington, D. C. Publication sent free to persons engaged in industrial hygiene in governmental agencies. Rates for others, $1 a year, domestic; $1.25, foreign. Superintendent of Documents, Government Printing Office, Washington 25, D. C.

ROUND COPPER SEAMLESS TUBES—The National Bureau of Standards has approved a Simplified Practice Recommendation for Copper and Copper Alloy Round Seamless Tube, identified as R235-48. The recommendation was proposed by the Copper & Brass Research Association on behalf of manufacturers of copper tube. For a copy of these recommendations write the Commodity Standards Division, National Bureau of Standards, Washington 25, D. C.

ASA STANDARDS—A 24-page booklet has been issued by the American Standards Association to list all the national standards approved by the association. For easy reference, there is an alphabetical index and groupings by general topics such as rubber, chemical industry, etc. American Standards Association, 70 E. 45th St., New York 17, N. Y.

NDHA SUBJECT AND AUTHOR INDEX—General subject and author index of proceedings and bulletins of the National District Heating Association for 1935-1944 inclusive. This index of 84 pages provides a cross index of material published by the society for a 10-year period. National District Heating Association, 827 N. Euclid Ave., Pittsburgh 6, Pa.

TESTING AND RATING BOILERS — The Commodity Standards Division, National Bureau of Standards, has made available printed copies of Commercial Standard CS145-47 on Testing and Rating Hand-Fired Hot Water Supply Boilers. The standard covers the testing and rating of all sizes of hand-fired solid fuel burning hot water supply boilers, except those of the magazine feed type and laundry type. Rating is expressed in Btu per hour, and in gallons of water heated to 100F in 3 hours. The standard is intended to eliminate confusion when purchasing boilers. Price 10 cents. Superintendent of Documents, Government Printing Office, Washington 25, D. C.

NEWS OF THE MONTH

ODOR CONTROL

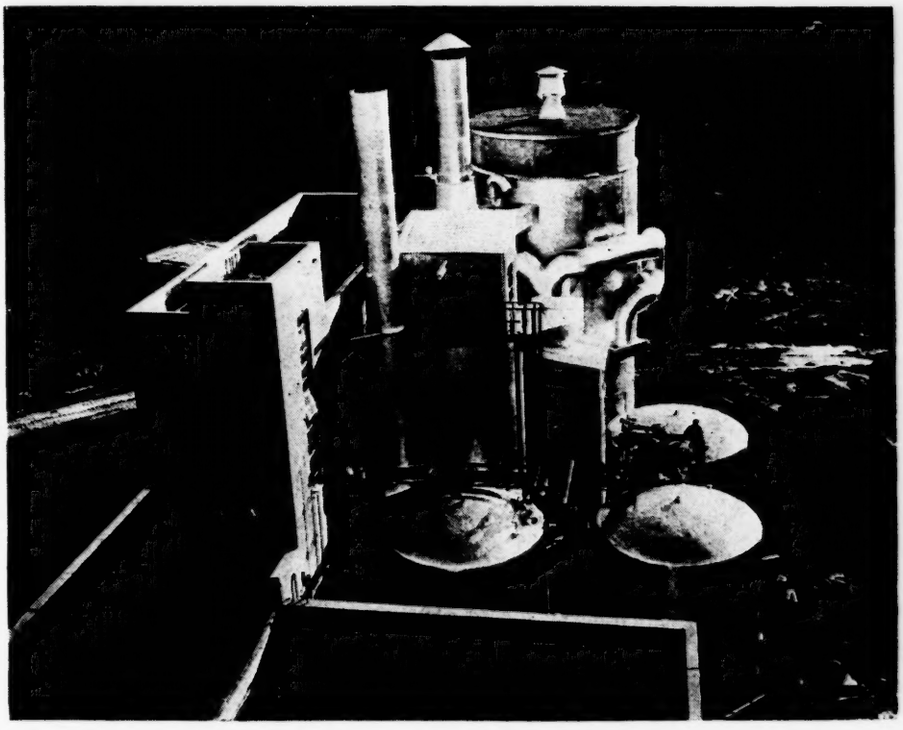
is pressing problem in processing penicillin culture medium for recovery of vitamin-rich by-product.

The manufacture of penicillin at Lederle Laboratories, Pearl River, New York, involves the daily processing of tons of culture medium for the growing of penicillin mould. When growth has reached a certain stage the penicillin drug is extracted and the medium becomes waste material. Efforts to dispose of large quantities of this waste resulted more or less accidentally in a by-product rich in Vitamin B and useful for enriching livestock feed. Because the firm is limited by local ordinance to disposal by drying, Lederele's chief problem grows from the strong fermentation odor sometimes produced in certain stages of the drying process.

• **THE PROCESS.**—Similar to many other fermentation processes, the culture of penicillin takes place in a medium or broth made up of water, corn steep liquor, lactose, calcium carbonate, phenol acetic acid, and lard oil. This mixture is first sterilized with steam, then inoculated with a seed charge of penicillin mould spores and allowed to ferment. When fermentation is finished, the penicillin is extracted and the spent broth remains to be disposed of.

Lederle has a similar process for the manufacture of riboflavin except that ingredients of the culture medium are varied slightly. The total waste product from the two processes is about 350,000 lb per day. Since this volume of waste could not be disposed of as ordinary sewage, Lederle engineers developed a system of spray drying which results in a vitamin-rich powder.

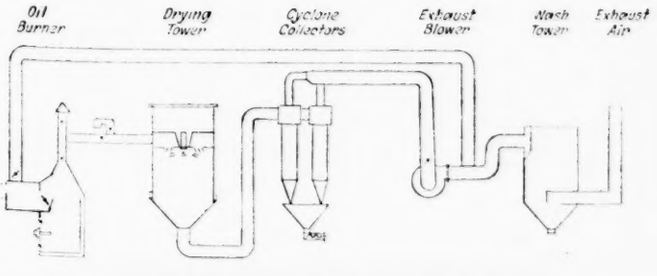
• **THE DRIER.**—The spray drier consists of an oil-fired furnace for the production of hot air which is introduced into a tower, from the top of which the penicillin slurry is sprayed downward. The air at 600F quickly reduces the spray to a fine powder which is exhausted by blowers and separated from the air in a series of cyclone dust collectors. The exhausted air is blown through a wash tower and then discharged. With this treatment the odor of the effluent gas is not objectionable except under occasional conditions.



A $2-million waste disposal plant with a profitable product.

As first arranged and built, however, the drying unit contained no cyclone separators and the dried powder was removed at the bottom of the drying tower. This arrangement was not satisfactory because of the fact that the powder clinging to the crevices of the tower became too hot and burned, producing an extremely disagreeable odor. Even now, with the system in constant operation, there are occasionally small smoldering fires resulting from spontaneous combustion of the material, and the plant must be shut down and thoroughly cleaned.

To heat the 40,000 to 45,000 cfm of hot air introduced to the drying tower, requires 80 to 90 gallons of oil an hour. The air and powder leave the drying tower through ducts to the cyclone separators at 2,500 to 3,000 fpm. Batches of powder collected at the cyclone separators are stored in separate bins, contents of which are analyzed individually. Blending the contents of the various bins results in a product of standard concentration with constant vitamin content.



Schematic diagram of drying process.

INSURERS' HOUSING PLANS

are shelved by soaring construction costs and uncertain investment yield.

Insurance companies, long active in the promotion of housing developments, have been increasingly harassed by the rising cost of home building. Many companies are shelving, at least temporarily, plans for many large scale rental housing projects.

Insurance companies' projects, such as Metropolitan Life's Parkchester, Stuyvesant Town, Peter Cooper Village, and others, have been the largest direct contribution toward relief of the housing shortage that has been made by any single private source. At the beginning of 1948 there were over 100,000 persons living in rental housing projects built and operated by life insurance companies and similar developments for another 100,000 people were being built.

• **SURVEY.**—The Institute of Life Insurance gives the following survey of life insurance companies' plans for the immediate future:

Metropolitan Life Insurance Co. has no plans for building any new housing units. Metropolitan has long been the trade's leader in the housing field, but its only present activity is the completion of projects already started.

Prudential Life Insurance Co. has shelved an ambitious plan for large-scale entry into the field. Back in 1946 it made a nationwide survey of housing needs, with the idea of investing some $100 million in moderate-rental developments. Thus far, only $5 million of this has been spent; only two small projects are under way.

Equitable Life Assurance Society has decided to postpone indefinitely construction of a 1,000-apartment project in New York City, for which it has already bought the land.

New York Life Insurance Co. is considering eventual expansion of its investment in housing projects. All such plans are still in the paper stage, however—except one project where rentals will run as high as $50 monthly per room. Otherwise, its only activity is completing housing projects already started.

The Mutual Life Insurance Co. of New York, other member of the trade's "Big Five," is also determined to maintain a hands off policy. So are a long list of smaller life companies.

• **NEW LAW.**—Take, for example, the Pennsylvania life companies. That State only recently passed a law which permits its native life insurers, like those in New York, to invest up to 10% of their assets in housing. So far, not one company has taken real advantage of the new law.

Philadelphia's Penn Mutual Life Insurance Co., Pennsylvania's largest life company, does intend to enter the field eventually. But John A. Stevenson, its president, recently said bluntly that his company won't build any housing projects until prices slide off "20% to 33%."

Another Philadelphia company is reported to have considered more than 30 sites for housing projects. It has already bought land on which it plans to build a 1,000-apartment project eventually. But it is going to do nothing until building costs come down.

• **MORTGAGES.**—Housing projects are only one phase of the insurance industry's activity in the field of real estate. Since V-J Day, for instance, it has loaned more money on homebuilding mortgages than all federal, state, and municipal bureaus combined. Through G.I. mortgages alone, homes for at least 500,000 persons have been financed by the insurance companies.

• **NEW HIGH.**—As a result, life insurers' mortgage holdings recently totaled more than $8 billion—a new high. And the companies still have substantial additional funds available for such investments.

Thus, the life insurance industry is convinced that its contribution to housing has gone far enough. Any further steps at this time are too risky.

• **MINIMUM YIELD REQUIRED.**—Any insurance company investment must promise a definite minimum yield; the amount depends on the safety of the principal. Housing projects must offer reasonable assurance of at least 3½% to 4½% yearly—over and above 2% annual amortization of principal.

A year or two ago, this assurance was present. But it has been evaporating rapidly. Because of today's high costs, much higher rentals than those usually charged must now be assessed to assure the required rate of return. And the life trade doubts that it will be able to maintain such inflated rental levels over the long term.

GAS EXPLOSIONS

direct attention of New York officials to possible hazards of high pressure gas distribution.

Recommendations that use of high pressure gas, now piped into more than 28,000 homes in metropolitan New York, be discontinued to prevent explosions were made by a special investigating committee appointed by Mayor William O'Dwyer as a result of two explosions which cost four lives and injury to 22 persons living in Queens. A report, signed by Commissioner Bernard J. Gillroy, Director of Housing and Buildings and Commissioner John M. Canella of the Department of Water Supply, Gas and Electricity, said that at the earliest possible moment, each police prowl car in the areas served by high pressure gas should be equipped with a valve key for shutting off gas service curb control valves. This practice is already carried out by Fire Department and Police emergency trucks.

The Investigating Committee's report included various measures for stopping the recurrence of such accidents including the use of a whistle on each pressure regulated gas unit, which will produce shrill warning of escaping gas. No enforcement steps have been taken pending further conferences between city and utility officials.

Representatives of utility companies contended that the two explosions would have occurred regardless of the pressure of gas and could not have been prevented by measures suggested in the Investigating Committee's report.

• **TWO EXPLOSIONS.**—It was pointed out that these are the only two explosions which have occurred on high pressure lines in the country. The first explosion occurred when a gas company workman, having repaired a supply valve, broke a defective part of the valve when turning the gas on. He could not stop the flow with a plug owing to irregular shape of the breech. He warned residents to vacate the premises and continued to try to plug the opening. When he gave up attempts to stop the leak, he staggered out of the house but he was too dazed to shut off the curb valve although he was sitting on the running board of his truck with his feet on the curb shutoff.

The second explosion occurred on May 4 when moving men lost control of a piano and broke a high pressure gas line projecting into the stairway. Investigation revealed that the owner had moved the stairway after the original gas installation and had not taken measures to protect the pipes. The house blew up while residents were waiting for a gas company man to shut off the gas at the curb.

ASHVE MEETING

at Bretton Woods features three technical sessions with papers by college and engineering authorities.

Weather was the topic at the first technical session of the 1948 Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, June 21-23 at the Mount Washington Hotel, Bretton Woods, N. H. Papers by W. F. Wells, associate professor, University of Pennsylvania; Donald B. Chapman, associate professor of geology, University of New Hampshire; C. P. Yaglou, professor of industrial hygiene, Harvard School of Public Health; and Nathaniel Glickman, assistant professor of medicine and research physiologist, Department of Medicine, University of Illinois, were presented.

• **VENTILATION.**—Professor William F. Wells, speaking on the sanitary significance of ventilation, emphasized the importance of irradiation as a means of combating infection, and stated: "during an average lifetime, a human being breathes several million cubic feet of air. Of this enormous total, more than a million cubic feet of confined air shared by other persons are breathed indoors." Infected persons expel into the atmosphere droplets that have virulent nuclei which drift about as media of contagion. Fortunately, he explained, the conditions conducive to air-borne infection are the very conditions most favorable for effective radiant disinfection.

Professor E. H. Stolworthy, Durham, N. H., gave Professor Chapman's paper on the Mount Washington Observatory. Cyril Tasker, Cleveland, read Professor Yaglou's paper on thermal insulation of clothing; and Professor Glickman talked on comparison of physiological adjustments of human beings during summer and winter.

• **WEATHER.**—Professor Stolworthy emphasized the importance, to meteorologists, of the vertical structure of the atmosphere and the value of mountain-top weather stations in the study of this structure. Mount Washington, he explained, is especially valuable because it towers above low, flat country, protruding into the storm systems. The Mount Washington Observatory has been in continuous operation since 1932. The world's highest surface air velocities (231 miles per hour) have been recorded at the Observatory.

• **CLOTHING.**—Mr. Tasker gave Professor Yaglou's paper on thermal insulation of clothing, in which the author stated that "the purpose of clothing is to provide insulation that will spare the body the necessity of harsh and radical adjustment to environmental changes." What is not well known, he emphasized, is the amount of insulation supplied by various kinds of clothing, and how much insulation is needed to maintain comfort at work or at rest under various environmental conditions. Evaluation of temperature gradients over different parts of the body is particularly desirable in any test, because adequacy of cold-weather clothing depends on insulation obtained over critical body areas. A heat loss method of evaluation, according to Professor Yaglou's report, has serious limitations if it deals only with over-all insulation of whole assemblies.

• **REACTION.**—Professor Nathaniel Glickman, the final speaker, presented his paper on physiological adjustments of human beings during summer and winter. ASHVE, in cooperation with the University of Illinois, College of Medicine, sponsored this study, in which Professor Glickman had as collaborators: Tohru Inouye, research assistant, Department of Medicine, University of Illinois; Dr. Robert W. Keeton, head of the Department of Medicine, University of Illinois; and Maurice K. Fahnestock, assistant director, Engineering Station, Department of Mechanical Engineering, University of Illinois.

"The purpose of the present paper," Dr. Glickman stated at the outset, "was to determine whether the body adjustments of these subjects differed in the winter from those reported in the summer." Essentially, findings were that after one hour's exposure to a "comfortable" environment, reactions were the same in summer and winter, with little evidence that seasonal adaptations were important in responses.

• **2ND SESSION.**—At the second technical session, three papers were presented: "Ground Temperature Distribution with a Floor Panel Heating System," by A. B. Algren, associate professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn.; "Theory of the Ground Pipe Heat Source for the Heat

Pump," by L. R. Ingersoll, professor, Department of Physics, University of Wisconsin, Madison, Wis., with the collaboration of H. J. Plass, assistant in physics at the university; and "Fan Selection by Use of Constants," by Arthur C. Stern, chief engineer, Division of Industrial Hygiene and Safety Standards, New York State Department of Labor, New York, N. Y., with the collaboration of Leon D. Horowitz, industrial engineer of the division.

• **GROUND.**—In his talk on ground temperature distribution, Professor Algren described a research project, which is to last approximately two years and cover ground temperature distribution, heat losses to the ground through concrete footing walls, and around the perimeters of concrete slabs, inside air temperature distribution, temperature distribution across the surface of the panel, and methods of control.

Carl Flink, technical secretary of ASHVE, gave L. R. Ingersoll's paper, "Theory of the Ground Pipe Heat Source for the Heat Pump." The author developed an analytical theory of the flow of heat from the earth to buried pipes, an elaboration of the Kelvin heat-source theory. On the basis of theory, he said, the temperature drop in a pipe is, in general, proportional to the rate of heat absorption; soil diffusity is a factor, although conductivity is, on the whole, more important; for a given length of pipe, a coil is much less efficient than the same length stretched more or less straight; and more pipe, rather than projections on a pipe, would seem desirable.

• **FANS.**—Arthur C. Stern, in his paper, "Fan Selection by Use of Constants," gave a simplified method of applying fan constants in establishing the rating of fans in the field. Mr. Stern emphasized the fact that he and his associate in this project had investigated several methods of simplifying fan rating and selection, and that their own method seemed to be the simplest of all. He frankly stated that, for office use, the detailed manufacturers' multirating table is more convenient but that his method gives, in one printed table in a notebook or brief case, the equivalent of many pounds of catalogs and multirating tables. "In practice," said Mr. Stern, "the method proposed will allow the selection of motor size to the same degree of accuracy as could be obtained through the use of a multirating table."

• **3RD SESSION.**—At the final technical session three papers on air conditioning problems were presented.

James P. Stewart, engineer at the Carrier Corporation, Syracuse, N. Y., spoke on, "Solar Heat Gain through Walls and Roofs for Cooling Load Calculations." Mr. Stewart made reference to data tables which accompanied his paper, and which, as he emphasized, "are intended for use in the interim period until theory and tests, particularly for roofs, can be brought into closer agreement." Mr. Stewart paid tribute to experiments at the ASHVE laboratory and to the method developed by C. O. Mackey and L. T. Wright, Jr. at Cornell, (H&V:12:44:p62) upon which he based his own investigations.

Charles S. Leopold, consulting engineer, Philadelphia, Pa., read a paper entitled "Hydraulic Analogue for the Solution of Problems of Thermal Storage, Radiation, Convection and Conduction."

"The mathematical solution of heat-diffusion problems is cumbersome at best," Mr. Leopold emphasized, "and when, as in this case, radiation, convection and conduction for two or more solids must be considered, mathematics is complicated beyond reasonable engineering application." Therefore, he said, an analogue has been constructed—a machine for solving such problems by utilizing the analogy between heat transfer and liquid flow, together with constants for source-energy distribution previously determined, thus providing "an insight into the true nature of the cooling load and the behavior of cooling systems."

George V. Parmelee, research fellow, ASHVE Research Laboratory, delivered a paper, "Solar and Total Heat Gain through Double Flat Glass." The speaker presented technical data and equations for the statement that the solar energy which is transmitted by glass from all sources equals the incident radiation, minus that absorbed, minus that reflected.

GAS AIR CONDITIONING

for year-'round comfort supported by electric companies in new pattern of promotion.

The current year is bringing a marked change in the pattern of gas all-year air conditioning. Electric utilities in some areas now are discussing the possibility of promoting sales of certain types of gas all-year air conditioning.

• **LOAD FACTOR.**—Air conditioning with gas as a fuel is attractive to electric utility companies in certain areas because electric utilities generally have not been particularly interested in acquiring a residential air conditioning load. In some cases, they have discouraged it because of the increased investment required to provide service to operate air conditioning equipment in residential areas and the low annual revenue derived from summer operation only.

After more than 15 years of research, development and field testing, gas all-year air conditioning now is an established and fast growing service in the gas industry. The American Gas Association's research program has contributed much to the development of gas all-year air conditioning, and projects still are under way to further its development.

• **EQUIPMENT.**—Servel, Inc., and Surface Combustion Corp. are in production on residential units and hundreds of such units are in operation in homes in every part of the country. Merchandising plans of many gas utilities for 1948 include promotion of gas air conditioning. Recent surveys indicate more than 30,000 immediate prospects in areas where no shortages exist

or in homes now equipped for gas heating in restricted areas.

Commerical and business areas also have proved profitable markets for gas air conditioning. Among the manufacturers of commercial gas air conditioning are Surface Combustion Corp., Bryant Heater Co. and Eureka Williams Corp.

Economic factors are causing an increasing number of gas utility companies to include promotion of air conditioning in their new sales programs. Restrictions on sales of gas househeating are gradually lifting. With the gas air conditioning load to fill the valleys during the summer months, a total system load that will yield a year-round profit can be achieved.

• **METHODS.**—Gas air conditioning, as it is in practical operation today is achieved under different processes. Under one method during the heating cycle steam is developed and delivered to a heating coil over which air is drawn. The heated air passes through a humidifier section where moisture is added and it is then delivered to the spaces to be heated. During the cooling cycle steam is delivered to an absorption refrigeration unit containing lithium bromide and water. Air is cooled and dehumidified as it passes over the cooling coil. The same equipment is used for both cycles and the winter-summer change-over is achieved by a flick of a switch.

With other methods, air conditioning is achieved by absorption of excess summer moisture in air through contact with lithium chloride or silica gel. Moisture is removed from the absorbents by application of gas heat or other means and the absorbents re-used in a continuing cycle. In winter months moisture can be added to the air. Air temperatures can be maintained, raised, or lowered independently under these processes and their flexibility and economical operation have recommended them extensively for industrial and commercial installations in hotels, theaters, night clubs, restaurants, stores and business locations.

Gas utilities often have been asked whether or not the reversed refrigeration cycle or heat pump, is adaptable to gas. Manufacturers of heat pumps today are producing this equipment for operation with gas as a fuel. With suitable equipment in the building this process can be applied either to winter heating or summer cooling or both.

• A recommended *revision of the fuel oils commercial standard* CS12-40, has been submitted to producers, distributors, and users of this product for written acceptance, according to an announcement by the Community Standards Division of the National Bureau of Standards.

• An Anthracite Institute Bulletin reports research by the Coleman Company showing that 33.8% of *oil burning space heaters* in the United States were operating in the New England and Middle Atlantic States, the primary marketing area for anthracite.

PIPING CONTRACTORS

report on association and business conditions at Pittsburgh, Pa., convention.

Thomas L. Eagan, Washington, D. C., was elected president of the Heating, Piping and Air Conditioning Contractors National Association at the annual convention held at the Hotel William Penn, Pittsburgh, Pa., June 2 to 4. About 600 members and guests were present. Other officers for the new term are L. L. McConachie, Detroit, vice-president; Wray M. Scott, Omaha, Neb., treasurer; Joseph C. Fitts, New York City, secretary.

• **RESEARCH PAPERS.**—Peter B. Gordan reported for the Radiant Panel Heating Committee that James M. Kane and Erich Ericksen of Case Institute of Technology were awarded the first prize of $300 for their paper on A Panel Heating Performance Study. They reported on the 50,000 readings that they had taken in the preparation of this paper. Announcement of this contest had been mailed to heads of engineering schools in 133 colleges and universities.

Second prize of $100 went to James N. Ayres of the University of California for his paper on Air Temperature Gradients in Panel Heated Structures.

Contest judges were Mario Giannini, Assistant Dean, College of Engineering, New York University; Walter E. Heibel, District Manager, Aerofin Corp., New York City; Doremus L. Mills, Research and Development Engineer, Revere Copper & Brass, Inc., Rome, N. Y.

This committee believes that the major radiant heating problem for the next several years will be the standardization of design data and that the cooperation of all industry groups will be required to achieve this simplification.

• **COMMITTEE REPORTS.**—The Home Heating Committee through J. A. Ljunggren, chairman, reported that pipe shortage has retarded progress in panel heating. Considerable activity has taken place in the field of baseboard radiation and there are more manufacturers producing this type of radiation now than in 1947. He said, "The future of some types of baseboard radiation will definitely hinge on the elimination of smudging the wall surfaces."

P. A. Edwards, chairman, Committee on Standards, stated that a new edition of Part 2 of the Engineering Standards on Net Square Feet Radiation Loads Recommended for Low Pressure Heating Boilers has been prepared by the Boiler Output Committee.

The Research Committee, of which John H. Zink is chairman, reported that at the request of the A.S.M.E., tests were made for evaluating the relative merits of flanges and the necessary limitation of flange design in higher pressure and temperature ranges. This work is about completed and when approved by the A.S.M.E., will be made public. A study is also being made to determine the best methods for making aluminum welds.

George P. Nachman reporting for the Committee on Trade Promotion said that while building construction for income purposes is bound to slow up soon, industrial building required by the new defense program will probably keep the grand total at the same level or higher.

John H. Zink stated that with the exception of the chapter on welding aluminum pipe, writing has been completed for all chapters for the Standard Manual on Pipe Welding. It is expected that this material will be sent to the printer soon.

The Committee on Air Conditioning, through its chairman, W. S. Bodinus, revealed that Part IV of the Engineering Standards, Comfort Air Conditioning, has been rewritten. In revised form it covers use of new psychrometric data—specifically the change in total heat values—using enthalpy instead of the sigma function.

Beside the many reports that were presented, a talk was given by E. Lawrence Chandler, Assistant Secretary, American Society of Civil Engineers on Business Conditions and Their Effect on Building.

John C. Hayes, counsel for the society, spoke on Labor Relations Under the Taft-Hartley Act.

A trip was made on Thursday, June 3, to the McKeesport plant of the National Tube Company where an opportunity was given to witness the manufacture of steel pipe. Prior to the trip, the company was host at a luncheon at the William Penn Hotel.

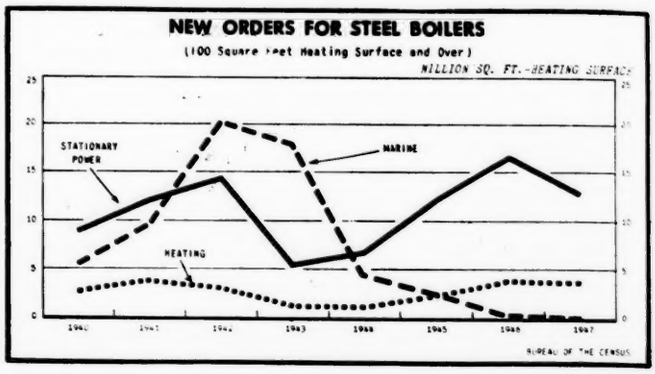
• **NEXT CONVENTION.**—Next year the convention will he held at the Statler Hotel, Detroit, Mich., June 8-10.

STEEL BOILER ORDERS

fall behind 1946 rate in Department of Commerce Summary for 1947.

During 1947 new orders for steel boilers (with 100 sq ft of heating surface and over) amounted to 16.9 million sq ft of heating surface, according to the Bureau of the Census, Department of Commerce. Stationary power boilers accounted for 13.0 million sq ft or about 77% of this total, while heating boilers accounted for only 3.9 million sq ft, and marine boilers for only 108 thousand sq ft. The heating surface ordered during 1947 went into 8,141 stationary power boilers, 7,935 heating boilers, and 35 marine boilers. The preponderance of heating surface in the stationary power category was due to the larger sizes of the stationary water tube boilers. Of the 13.0 million sq ft of stationary power boilers ordered, 9.9 million were of the stationary water tube type and the remaining 3.1 million were of the stationary fire tube type.

In terms of heating surface, total orders booked during 1947 were 18% below the 1946 total of 20.7 million sq ft and 56% below the 1942 total of 38.1 million sq ft, the highest point on record. The decline



from 1946 to 1947 was due to the stationary power boilers which dropped from 16.7 million to 13.0 million sq ft. Heating and marine boilers were at about the same level during both years. The drop from 1942 to 1947 was principally due to the almost complete disappearance of orders for marine boilers. War orders during 1942 brought the total for marine boilers up to an all-time record peak of 20.4 million sq ft. In the last 2 years orders for marine boilers have fallen to an insignificant amount.

In terms of number of boilers, 1947 orders for 16,111 boilers were 17% below the 1946 total of 19,473 boilers. The number of boilers ordered in 1946 was higher than in any other year since 1928.

NEWS BRIEFS

• A complete *new manufacturing plant* and headquarters offices will be constructed by the Lincoln Electric Co. at East 178th Street and St. Clair Avenue, Cleveland. The Austin Co. has studied preliminary plans which involve about 25 acres of floor space on a 50-acre tract. The new facilities will completely replace the company's present plant.

• Drafts of the proposed *uniform plumbing code for housing* developed by HHFA were sent recently to groups in the construction field. Practically all replies received by HHFA have been favorable and requests for information on the proposed code have been received from a number of cities.

• Individually controlled *air conditioned staterooms* are featured on the Matson Navigation Company's *S. S. Lurline*, which was recently placed in service between San Francisco and Hawaii. Automatic controls by Johnson Service Co. allow individual thermostat settings in staterooms, crew quarters, dining rooms, lounges, and other public areas. Fred Linandar, Johnson Service technician, sailed on the liner's shakedown cruise and made final adjustments of the air conditioning control system.

(More News Briefs on Page 116)

IF YOU HAVE A PROBLEM ON RADIANT PANEL HEATING

YOUR REVERE DISTRIBUTOR CAN HELP YOU

1. If you have a problem in connection with design or installation of a radiant panel heating system, your Revere Distributor—or, through him, the Revere Technical Advisory Service—will gladly help you solve it.

2. If you need literature to help you explain radiant panel heating to your customers, your Revere Distributor will obtain for you a free copy of "Radiant Panel Heating—a non-technical discussion." This easy-to-read, illustrated book—prepared by the Research and Development Department of Revere and leading heating consultants—answers most of the questions your customers are asking.

3. And, of course, your Revere Distributor can always supply Revere Copper Water Tube in the easy-to-bend soft temper that is ideal for radiant panel heating. This tube is quick and easy to install, and you know you can depend on it to give a lifetime of trouble-free service.

Remember—for radiant panel heating as well as other heating and plumbing installations—*trouble always costs more than Revere Copper Water Tube.*

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; New Bedford, Mass.; Rome, N. Y. — Sales Offices in Principal Cities, Distributors Everywhere.

DEGREE-DAYS FOR MAY, 1948

HEATING AND VENTILATING's 21st Year of Publication of Monthly Degree-Day Data

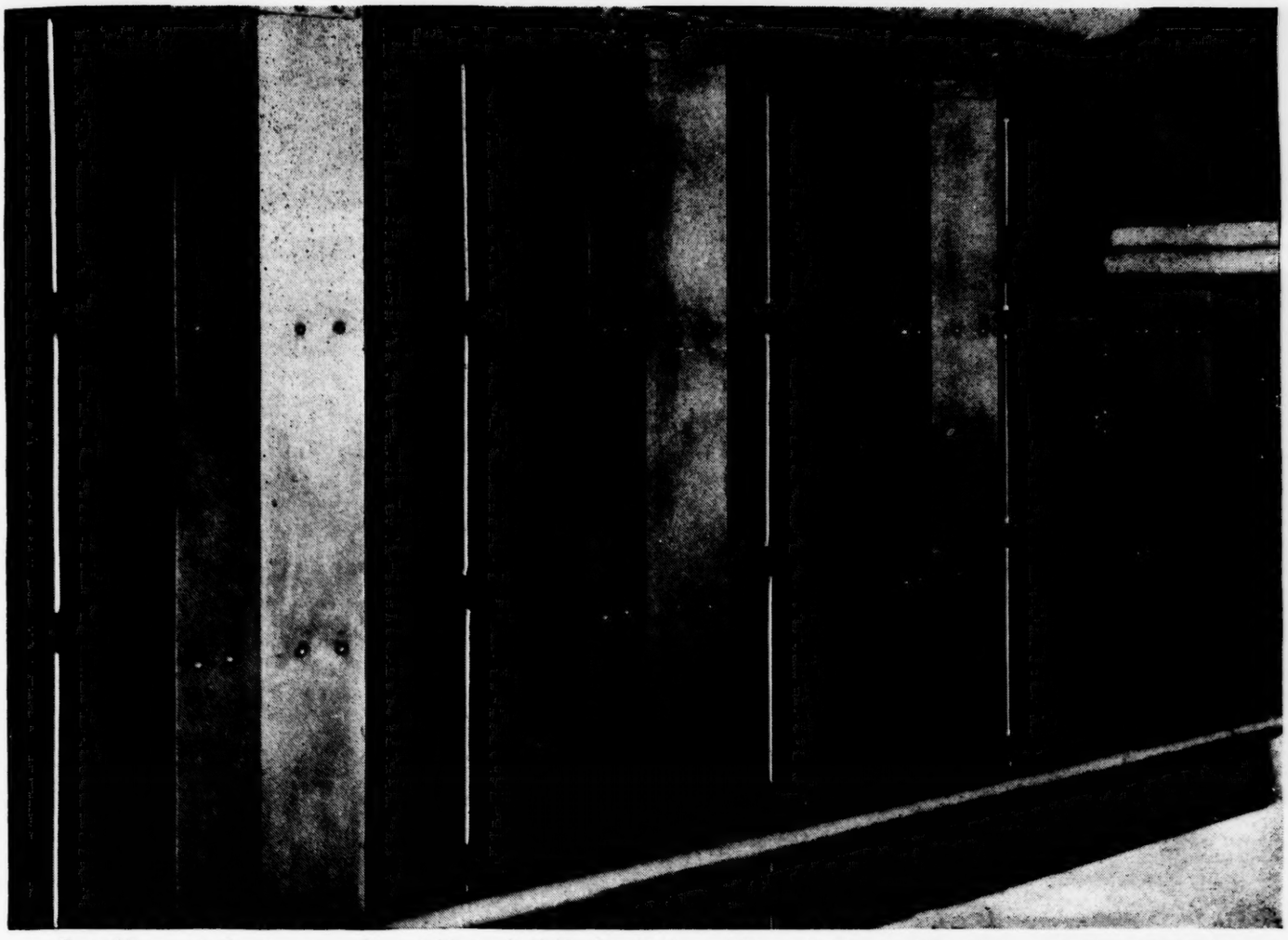
City	May			Cumulative, Sept. 1 to May 31			Heating Season[1]
	1948	1947	Normal	1947-48	1946-47	Normal	Normal
Abilene, Texas	13	23	0	2853	2838	2061	2061
Albany, New York	290	281	549	7398	6629	6397	6580
Albuquerque, New Mexico	61	48	40	4601	4289	4298	4298
Alpena, Michigan	487	574	465	7884	7849	8127	8299*
Anaconda, Montana	480	377	517	8259	8057	8010	8357**
Asheville, North Carolina	80	129	71	3903	4075	4232	4232
Atlanta, Georgia	9	43	0	2830	2873	2890	2890
Atlantic City, New Jersey	222	232	220	5065	4519	5176	5176
Augusta, Georgia	1	16	0	2289	2191	2161	2161
Baker, Oregon	449	230	431	6734	6613	6950	7163
Baltimore, Maryland	80	126	22	4469	4071	4533	4533
Billings, Montana	284	277	316	6994	7311	7059	7119
Binghamton, New York	278	260	254	6700	6152	6808	6808
Birmingham, Alabama	10	41	0	2765	2783	2352	2352
Bismarck, North Dakota	301	423	338	9245	8929	9147	9192
Block Island, Rhode Island	390	386	378	5955	5269	5689	5788
Boise, Idaho	304	146	236	5966	5779	5552	5552
Boston, Massachusetts	313	286	245	6162	5409	6045	6045
Bozeman, Montana	395	336	471	8037	7705	8195	8521**
Buffalo, New York	372	376	335	6697	6451	6810	6822
Burlington, Vermont	349	341	273	8070	7370	7511	7514
Butte, Montana	452	390	502	8692	8474	7926	8235**
Cairo, Illinois	24	61	0	3945	3783	3909	3909
Canton, New York	365	407	334	8148	7714	8020	8020
Charles City, Iowa	400	629	224	7139	6968	7588	7588
Charleston, South Carolina	0	10	0	1944	1724	1769	1769
Charlotte, North Carolina	12	46	0	3177	3028	3120	3120
Chattanooga, Tennessee	27	72	0	3239	3433	3118	3118
Cheyenne, Wyoming	379	478	446	7365	7467	7340	7466
Chicago, Illinois	324	351	254	6093	5992	6077	6077
Cincinnati, Ohio	89	149	0	4570	4467	4684	4684
Cleveland, Ohio	268	283	220	6050	5853	6155	6155
Columbia, Missouri	80	143	22	4830	4886	4922	4922
Columbia, South Carolina	2	19	0	2495	2296	2364	2364
Columbus, Ohio	155	218	87	5288	5220	5398	5398
Concord, New Hampshire	385	349	298	7874	7180	7299	7353
Concordia, Kansas	113	194	65	5513	5532	5315	5315
Dallas, Texas	4	11	0	2693	2476	2256	2256
Davenport, Iowa	192	257	118	6165	6039	6289	6289
Dayton, Ohio	180	248	81	5787	5668	5264	5264
Deer Lodge, Montana	418	345	487	8006	7583	8347	8672**
Denver, Colorado	202	292	267	7571	5861	5874	5874
Des Moines, Iowa	153	270	118	6282	6351	6384	6384
Detroit, Michigan	298	352	226	6522	6280	6490	6490
Devils Lake, North Dakota	342	508	424	10145	9840	9874	9970
Dodge City, Kansas	124	176	47	5395	5272	5035	5035
Dubuque, Iowa	227	316	149	6677	6628	6790	6790
Duluth, Minnesota	436	549	521	9312	9290	9267	9483
Eastport, Maine	596	520	543	8032	7297	7941	8520**
Elkins, West Virginia	234	265	177	5584	5718	5697	5697
El Paso, Texas	0	1	0	2908	2708	2428	2428
Ely, Nevada	504	357	(a)	7744	7357	(a)	(a)
Erie, Pennsylvania	333	340	257	6066	5845	6273	6273
Escanaba, Michigan	501	602	490	8397	8302	8608	8771
Evansville, Indiana	81	157	0	4739	4662	4244	4244
Fort Smith, Arkansas	21	33	0	3437	3336	3147	3147
Fort Wayne, Indiana	227	285	130	6368	6239	5925	5925
Fort Worth, Texas	4	19	0	2720	2532	2148	2148
Fresno, California	67	4	0	2611	2552	2334	2334
Galveston, Texas	0	0	0	1445	1407	1016	1016
Grand Junction, Colorado	118	79	118	5989	5654	5548	5548
Grand Rapids, Michigan	298	381	174	6467	6367	6535	6535
Green Bay, Wisconsin	353	481	322	7924	7744	7825	7825
Greensboro, North Carolina	35	78	0	3839	3758	3529	3529
Greenville, South Carolina	21	39	0	3166	3075	3380	3380
Harrisburg, Pennsylvania	158	187	90	5690	5097	5375	5375
Hartford, Connecticut	254	273	202	6578	5809	6036	6036
Hatteras, North Carolina	3	49	0	2421	2252	2571	2571
Havre, Montana	276	324	369	7798	8601	8556	8700
Helena, Montana	392	342	402	7862	7887	7663	7894**
Houston, Texas	0	0	0	1557	1489	1157	1157
Huron, South Dakota	254	353	267	8167	7945	8004	8004
Indianapolis, Indiana	129	188	59	5306	5172	5298	5298
Jackson, Mississippi	3	5	(a)	2296	2233	(a)	(a)
Kansas City, Missouri	79	127	6	4962	4869	4956	4956
Knoxville, Tennessee	40	89	0	3442	3655	3670	3670
La Crosse, Wisconsin	266	402	183	7828	7648	7322	7322
Lander, Wyoming	343	350	428	7677	7785	7812	7947
Lansing, Michigan	335	399	229	7012	6781	7048	7048

(a) Data not available.

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

Figures in this table, with eight exceptions, based on local weather bureau reports. Exceptions are Utica, Lewiston, Sioux City, figures for which are furnished through the courtesy of Coke Sales Department, Central New York Power Corp., Utica, N. Y.; Norman E. Ross, Bursar, Bates College, Lewiston, Me.; and Alfred R. Wagstaff, Engineer, Sioux City Foundry and Boiler Co., Sioux City, Iowa, respectively; Anaconda, Bozeman, Butte, Deer Lodge and Livingston, Mont., through the courtesy of the Montana Power Company.

[Table concluded on Page 110]



One of four central systems, supplemented by 91 individual unit air conditioners in Famous-Barr Department Store, St. Louis. System engineered and units manufactured by Carrier Corporation.

Cleaning Air at Low Cost

Low original cost! High dust-catching efficiency! Low maintenance cost! These advantages are outstanding in the use of DUST-STOP* replacement-type air filters in air conditioning the Famous-Barr Department Store in St. Louis.

Shown above is one of the four central filter installations supplying clean air to duct systems. Note how the filters are loaded with dust and dirt that will never have the chance to soil valuable merchandise. Soon they will be replaced with new, clean DUST-STOPS—at low cost.

There are good reasons why DUST-STOPS are specified by heating, ventilating and air-conditioning engineers. The packs of FIBERGLAS† fibers make an exceptionally efficient filter medium. Being glass—and inorganic—the fibers have no odor, nor will they rot or decay. And they do not absorb the non-odorous, non-evaporating adhesive with which they are coated. As a result, each impinged particle of dust is quickly soaked, acting as a wick to catch still more dust—until the DUST-STOP is so heavily loaded that resistance to air flow calls for replacement.

Complete details of metal frame assemblies, enabling you to design DUST-STOP panels to meet all space and CFM requirements, are given in our folder D47-34. Write for it, today . . . Owens-Corning Fiberglas Corporation, Dept. 912, Toledo 1, Ohio.

In Canada: Fiberglas Canada Ltd., Toronto, Ontario.

DUST STOP AIR FILTERS —a Fiberglas product

*T. M. REG. U. S. PAT. OFF.

†FIBERGLAS is the trade-mark (Reg. U.S. Pat. Off.) for a variety of products made of or with glass fibers by Owens-Corning Fiberglas Corporation.

Degree-Days for May, 1948 (Concluded)

HEATING AND VENTILATING's 21st Year of Publication of Monthly Degree-Day Data

City	May			Cumulative, Sept. 1 to May 31			Heating Season[1]
	1948	1947	Normal	1947-48	1946-47	Normal	Normal
Lewiston, Maine	394	406	344	7710	7348	7662	7707
Lincoln, Nebraska	126	198	99	6017	5855	5999	5999
Little Rock, Arkansas	9	25	0	3223	3102	2811	2811
Livingston, Montana	370	365	405	7340	7489	7043	7245**
Los Angeles, California	75	67	90	1531	1335	1504	1504
Louisville, Kentucky	66	137	264	4351	4277	4180	4180
Lynchburg, Virginia	58	108	0	4259	4158	3980	3980
Macon, Georgia	3	22	0	2337	2286	2201	2201
Madison, Wisconsin	310	391	236	7432	7149	7429	7429
Marquette, Michigan	534	650	496	8292	8369	8464	8693*
Memphis, Tennessee	16	37	0	3371	3152	2950	2950
Meridian, Mississippi	4	14	0	2336	2347	2160	2160
Milwaukee, Wisconsin	399	474	350	7153	7170	7206	7245
Minneapolis, Minnesota	228	359	236	8008	7888	7850	7850
Modena, Utah	354	216	350	6987	6162	6520	6562
Montgomery, Alabama	1	5	0	2017	1963	1884	1884
Nantucket, Massachusetts	421	405	384	6185	5523	5834	5957
Nashville, Tennessee	27	102	0	3664	3655	3507	3507
New Haven, Connecticut	283	311	223	6338	5640	5895	5895
New Orleans, Louisiana	122	0	0	1524	1219	1024	1024
New York, New York	209	216	171	5357	4833	5244	5274***
Nome, Alaska†	1227	1269	1443	12082	12272	12085	14580**
Norfolk, Virginia	22	60	0	3332	3069	3350	3350
North Head, Washington	412	348	422	4639	4508	4693	5452**
North Platte, Nebraska	186	258	199	6103	6350	6366	6366
Oakland, California	271	144	205	3156	2877	2870	3143**
Oklahoma City, Oklahoma	43	58	0	3821	3601	3613	3613
Omaha, Nebraska	123	214	84	6217	6142	6131	6131
Oswego, New York	431	388	357	6976	6528	7025	7088
Parkersburg, West Virginia	133	177	53	4748	4653	4775	4775
Peoria, Illinois	180	263	121	6012	6021	6109	6109
Philadelphia, Pennsylvania	134	165	115	4913	4405	4720	4737***
Phoenix, Arizona	0	0	0	1651	1278	1405	1405
Pittsburgh, Pennsylvania	193	183	78	5450	5353	5235	5235
Pocatello, Idaho	343	207	332	6934	6570	6595	6655
Portland, Maine	467	426	366	7672	7129	7137	7218
Portland, Oregon	253	109	245	4142	3827	4379	4469
Providence, Rhode Island	253	243	251	5901	5232	6015	6015
Pueblo, Colorado	185	203	186	6025	5872	5514	5514
Raleigh, North Carolina	10	48	0	3363	3104	3234	3234
Rapid City, South Dakota	356	375	344	7101	7611	7088	7118
Reading, Pennsylvania	152	184	96	5288	4861	5389	5389
Red Bluff, California	134	14	(a)	3079	2557	(a)	(a)
Reno, Nevada	403	160	366	6201	5525	5802	5892
Richmond, Virginia	39	83	0	3919	3615	3695	3695
Rochester, New York	366	334	260	6858	6450	6732	6732
Roseburg, Oregon	298	154	267	4355	4096	4314	4428
Roswell, New Mexico	24	27	0	3951	3479	3484	3484
Sacramento, California	144	24	53	2976	2677	2653	2653
St. Joseph, Missouri	84	169	16	5469	5257	5161	5161
St. Louis, Missouri	65	115	0	4622	4501	4585	4585
Salt Lake City, Utah	234	133	236	5979	5756	5555	5555
San Antonio, Texas	0	0	0	1859	1844	1202	1202
San Diego, California	85	45	115	1611	1340	1639	1645
Sandusky, Ohio	237	274	183	5972	5706	6208	6208
San Francisco, California	293	231	264	2747	2632	2681	3264**
Sault Ste. Marie, Michigan	516	674	502	8888	8943	8950	9285**
Sayannah, Georgia	0	6	0	1729	1585	1490	1490
Scranton, Pennsylvania	238	245	171	6262	5806	6129	6129
Seattle, Washington	313	163	316	4478	4198	4695	4934**
Sheridan, Wyoming	313	333	403	7407	7643	7888	8008
Shreveport, Louisiana	2	0	0	2454	2272	1938	1938
Sioux City, Iowa	188	293	164	6905	7127	6898	6898
Spokane, Washington	395	185	285	6743	6229	6274	6355
Springfield, Illinois	94	159	56	5162	5213	5373	5373
Springfield, Missouri	99	131	12	4684	4682	4428	4428
Syracuse, New York	345	300	267	7042	6498	6881	6893
Tacoma, Washington	340	210	332	4847	4594	4883	5181**
Terre Haute, Indiana	146	191	0	5459	5130	4872	4872
Toledo, Ohio	268	304	180	6460	6204	6077	6077
Topeka, Kansas	76	131	34	5058	4983	4969	4969
Trenton, New Jersey	168	186	81	5333	4778	4933	4933
Utica, New York	309	259	253	7219	6003	6796	6796
Valentine, Nebraska	273	340	273	6991	7269	7039	7039
Walla Walla, Washington	(a)	63	171	(a)	4582	4808	4808
Washington, D. C.	77	121	25	4368	4036	4626	4626
Wichita, Kansas	83	114	0	4764	4727	4673	4673
Williston, North Dakota	313	440	362	8953	9184	9269	9323
Winnemucca, Nevada	335	129	324	6321	5790	6274	6427**
Yakima, Washington	263	71	186	5821	5471	5599	5599

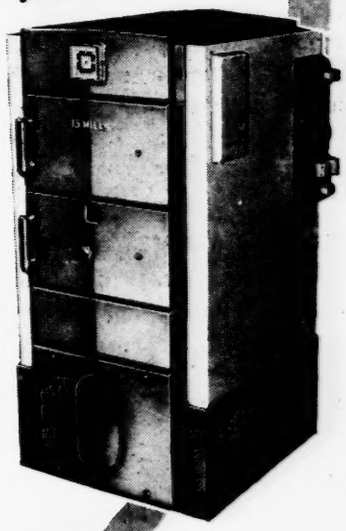
(a) Data not available.
†Nome data are for April.

*Includes August.
**Includes July and August.
***New 48-year normal covering 1898 to 1946.

[1]Figures in this column are normal totals for a complete heating season, September to June, incl.

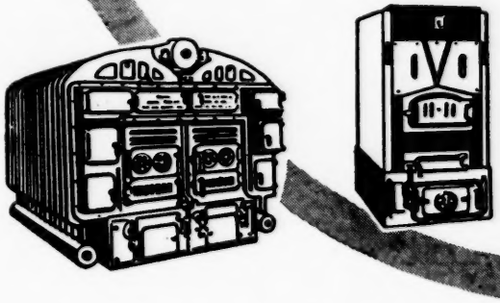
Announcing THE NEW 1500 SMITH-MILLS OIL BURNING BOILER for small homes

Again H. B. Smith, the leader in the development of integral boiler and hot water heater combinations, offers a new oil-fired boiler with built-in tankless heater — for the one-bathroom home. It's *compact*, because the heater is completely and neatly contained in the rear section of the boiler, without space-wasting outside heater or tank . . . *efficient*, because it provides a steady and ample supply of domestic hot water . . . *easily installed*, because it's designed for speedy assembly on the job.



But that's not all! The new Smith-Mills 1500 is economical, efficient, simple in operation, good looking — all in all a clever package, typical of the modern H. B. Smith Company.

Be sure to investigate the new Smith-Mills 1500 when homeowners ask for a boiler that delivers the best at lowest cost.



H. B. Smith
CAST-IRON BOILERS

THE H. B. SMITH CO., INC., 63 MAIN ST., WESTFIELD, MASS. • Offices and Representatives in Principal Cities

NEW CATALOGS

Filters

The Staynew line of filters for air and other gases, liquids and chemicals is described in a 44-page catalog. The line includes pipe line filters, air intake filters, liquid filters, and ventilating and air conditioning filters.—*Dollinger Corp., 11 Centre Park, Rochester 3, N. Y.* 117

Water Level Controls

A new line of electric boiler water level controls, said to eliminate floats, moving parts, packing glands, bellows seals, and mercury tubes, is described in bulletin 2713. Three models are described for various type service. Each model consists of an electrode chamber and a relay panel.—*Penn Electric Switch Co., Goshen, Ind.* 118

Atomizing Nozzles

Pneumatic atomizing nozzles are described and illustrated in Catalog No. 23 with tables of data showing spray dimensions resulting from various water and air pressures for various types of nozzles. Types included are those producing round spray, wide angle spray and flat spray. Supplementary information concerning accessories is included.—*Spraying Systems Co., 4021 W. Lake St., Chicago 24, Ill.* 119

Refrigeration Testing Equipment

A new 32-page catalog presents a complete line of temperature, altitude and humidity simulating equipment. Included are electric pressure temperature graphs, thermal property tables for various materials, and other data useful in research testing and production processing.—*Bowser, Inc., Refrigeration Division, Terryville, Conn.* 120

Fractional Horsepower Motors

Catalog No. 348 illustrates the entire line of EMC electric motors and bases and suggests methods of engineering for specific jobs. The catalog also features gear reducers.—*The Electric Motor Corp., Racine, Wis.* 121

Fans

The Frigid line of air circulators, exhaust fans, window ventilators, and centrifugal blowers is described in an 8-page catalog.—*Circulators & Devices Manufacturing Corporation, 22 Rose St., New York 7, N. Y.* 122

Fume Separator

An illustrated 4-page circular describes the new Niehaus fume separator with typical installations, capacities and specifications. This equipment is for recirculation of air exhaust from building and cleaning tanks.—*Industrial Electroplating Co., Inc., 219 W. Vermont St., Indianapolis 4, Ind.* 123

Flow Meters

Ring Balance mechanical flow meters, Series 2200-2600, are described and illustrated in detail with photographs, diagrams, and data on dimensions and capacities in a new 12-page bulletin, No. 2M48.—*Hagan Corp., 323 Fourth Ave., Pittsburgh, Pa.*.....124

Steam Turbines

Bulletin 1961 describes the Type S multi-stage steam turbine. Photographs, diagrams and cutaway drawings illustrate various parts and features of the equipment.—*Worthington Pump and Machinery Corp., Harrison, N. J.* 125

Industrial Roof Ventilators

An induced draft roof ventilator, called the Iron Lung, is described with installation photographs and construction details in a 22-page catalog.—*Powermatic Ventilator Company, 4019 Prospect Avenue, Cleveland 3, Ohio.* 126

Plastics

The forms, properties and applications of Vinylite resins and plastics are described in a 38-page booklet illustrated in full color.—*Bakelite Corp., 30 E. 42nd St., New York 17, N. Y.* 127

Electric Duct Heaters

Electric blast coil heaters or duct heaters in capacities from 3,400 to 1,023,000 Btu, are described in bulletin E97.—*Industrial Engineering Equipment Co., 711 South Theresa Ave., St. Louis 3, Mo.* 128

Annual Review

The 1947 annual review of engineering developments at Allis Chalmers commemorates the one-hundredth anniversary of the company and describes current activities in production of power generation and distributing equipment, metallurgy, coal production, farm equipment, manufacturing and other activities of the company.—*Allis Chalmers Manufacturing Co., Box 512, Milwaukee 1, Wis.* 129

Heating Equipment Selection

An Anthracite Institute bulletin tells how to choose the right solid fuel heating equipment for apartments, office buildings, and commercial use. Bulletin includes photographs of available equipment and suggestions for estimating comparative fuel costs. A companion bulletin offers similar information regarding residential installations.—*Anthracite Institute, 101 Park Avenue, New York 17, N. Y.* 130

Roof Ventilators

Breidert Air-X-Hausters are described in an 8-page bulletin. Said to incorporate new principles of roof ventilator construction, the Breidert line includes ventilators for homes, commercial buildings and factories.—*G. C. Breidert Co., 3129 San Fernando Road, Los Angeles 41, Calif.* 131

B. Altman & Company, N. Y. – H. L. Green Dept. Store, Utica – Kessler's, Birmingham – R. H. Macy & Company, Brooklyn – Jordan Marsh Co., Boston – Tiffany & Co., N. Y. – F. W. Woolworth Co., Quincy, Mass. – F. W. Woolworth Co., Stamford, Conn. – Younker Bros., Des Moines — Younker Bros., Ft. Dodge – Younker Bros., Marshalltown, – Dairy-Dell Inc., Johnstown, Pa. – Armstrong Paint & Varnish Co., Chicago – F. B. Badger & Sons Co., Cambridge – Chamber of Commerce, Washington, D. C. – Columbia Iron & Metal Co., Cleveland – Crawley-Gorbandt, Atlanta – Minnesota Linseed Oil Co., Minneapolis – National Smelting Company, Cleveland – New York Stock Exchange – Hotel Pennsylvania, N. Y. – Charles Pfizer Company, Long Island City – Pullman Standard Car Mfg. Co., Birmingham – United Benefit Life Insurance, Omaha – Western Union, Boston – Wright Aeronautical, Woodridge, N. J. – Emerson Electric Co., St. Louis – Mass. Institute of Tech., Pittsburgh Plate Glass Company, Creighton, Pennsylvania – Cambridge, Mass. – – Pittsburgh Plate Glass Company, Georgia School of Ford City, Pennsylvania – Tech., Atlanta – Sterling-Winthrop Research U. S. N. Photo-grammetry Lab., Institute, Rensselaer, Ft. Washington, N. Y. – University of N.Y. – Richmond Colorado, Denver – Radio Cor-poration Rockefeller Inst., N.Y.– Richmond, Station WBBR, N. Y. – Virginia – Elks Club, Brainerd, Minn. Windsor –Madison Square Garden, School, Des Moines – Fidelity-N. Y. – Yorktown Theatre, Deposit Co. of Maryland, N. Y. – People's Bank of Cleveland – Manufacturers' McKeesport, Pa. – Pine Lawn Bank & Trust Company, St. Louis – Trust Company, New York – Serial Federal Savings & Loan Assoc., N. Y. – Joy Young Restaurant, Birmingham — Walton Lunch Company, Boston – Chrysler Corp., Dodge Division, Detroit – Western Electric Company, Allentown – Eli Lilly & Company, Indianapolis – Novocol Chemical Mfg. Co., Brooklyn – E. R. Squibb & Sons, Long Island City – Our Lady of Lourdes Hospital, Camden – Veterans Hospital, Poplar Bluff, Mo. – Carnegie-Illinois Steel Co., Irvin Pa. – Carnegie-Illinois Steel Co., Vandergrift, Pa. – Crucible Steel Co. of America, Midland, Pa. – Tennessee Coal, Iron and R. R. Co., Birmingham – Adelaide Mills, Anniston, Ala. – Cleveland Cloth Mills, Shelby, N. C. – Dixie Mercerizing Company, Chattanooga – Dunean Mills, Greenville – Narricott Mills, Philadelphia – National Weaving Company, Lowell, N. C. – Standard Knitting Mills, Knoxville – Stonecutter Mills, Spindale, N. C. – New York Telephone Co., Lancaster, N. Y. – Cleveland Electric Illum. Co., Cleveland – Biersach & Niedermeyer, Milwaukee, – Blue Moon Cheese Co., Thorpe, Wis. – Shenango Pottery Company, New Castle, Pa. – George Evans Corp., Moline – Glass Fibers, Waterville – Intertype Corporation, Brooklyn – Lectrovision, Inc., New Rochelle – Rolock, Inc., Fairfield, Connecticut

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District Heating

A brochure on central heating of the Civic Center of Pittsburgh continues a series of case histories on district heating giving a detailed account of the co-operation of cultural, educational and medical institutes in organizing a central heating system covering an extensive area in the Oakland district.—*The RicwiL Co., Dept. 18C, Union Commerce Building, Cleveland, Ohio.* 132

Heating Coil Data

A data bulletin No. 30-C-4 presents engineering and installation data on fin coils. Tables of nominal tube lengths and face areas are included for each design. Other data deal with air volume ventilators, final air temperatures, static pressures, steam pressures, face velocities, etc. A companion bulletin gives pertinent data on fin tube cooling coils. — *McQuay Inc., 1600 Broadway, N.E., Minneapolis 13, Minn.* 133

Scotch Boilers

All-welded Scotch boilers for low pressure heating are described in Bulletin No. 9000. These boilers are made for oil, gas, or stoker firing and conform with ASME and SBI codes.—*Johnston Brothers, Inc., Ferrysburg, Mich.* 134

Boiler Performance Reports

Two bulletins, Nos. 479 and 481, present case histories of boiler water level control and boiler feed control respectively. Reports include tables of significant data, photographs, and drawings.—*Northern Equipment Co., Erie, Pa.* 135

Mercury Switches

In a manual on mercury switches setting forth details on types, applications, engineering data and other information, more than 60 different types of mercury switches are fully described.—*Minneapolis-Honeywell Regulator Company, Specialties Division, Minneapolis, Minn.* 136

Vertiflow Unit Heaters

A 16-page catalog, No. 2648, describes a new line of Vertiflow unit heaters said to deliver efficiently from high ceiling installation. The catalog contains complete descriptive and illustrative data on the line and includes diagrams, performance data, etc.—*Young Radiator Co., Racine, Wis.* 137

Hot Water Heat Engineering Data

Simplified engineering and installation data, wiring diagrams and typical details on radiant heating as well as conventional type hot water heating systems are presented in an 18-page booklet, Form FCE 648. Especially novel is the section on radiant heating which reduces procedure to two simple formulas, one for lineal feet of pipe required and one for determining spacing of pipe centers. — *H. A. Thrush & Co., Peru, Ind.* 138

Boiler Draft Fans

A 20-page bulletin on precision speed control for boiler draft fans discusses principles of operation, with graphs, diagrams and installations.—*Electric Machinery Manufacturing Company, Minneapolis 13, Minn.* 139

Sump Pumps

Catalog No. 441 features new high capacity models of Imperial floatless sump pumps. Drawings and tables of data supplement photographs and selection information.—*The Imperial Brass Manufacturing Co., 1200 W. Carroll St., Chicago, Ill.* 140

Direct Fired Unit Heater

Bulletin No. 300, 8 pages, describes the new Thermobloc direct fired unit heater. Heater delivers 550,000 Btu per hr and is said to have an efficiency of 82 to 86% burning No. 3 oil or lighter, or gas.—*Thermobloc Division, Prat-Daniel Corp., East Portchester, Pa.* 141

Centrifugal Blowers

Bulletin 6A-4 covers light weight Hi-Flo centrifugal blowers in the 4- to 18-oz pressure range, 6,000 to 48,000 cfh capacities. The bulletin includes photographs, diagrams, and selection tables.—*Bryant Heater Co., Industrial Div., 1020 London Rd., Cleveland 10, Ohio.* 142

Centrifugal Pumps

Bulletin W-305-B1 describes types CN and CNE centrifugal pumps for belt and motor drive. Specifications, ratings, and dimensions are given for closed impeller, single stage units for pumping hot or cold water, brine, process liquors, light oils and similar liquids. — *Worthington Pump and Machinery Corp.*, Harrison, N. J. 143

JULY, 1948

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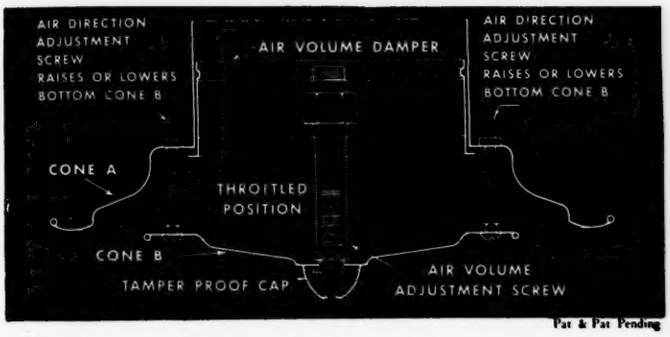
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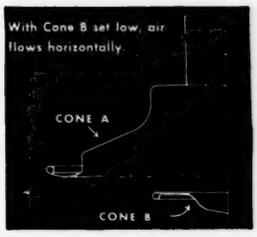

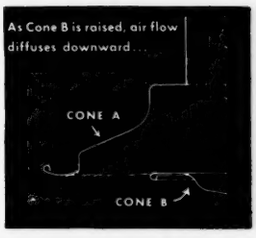

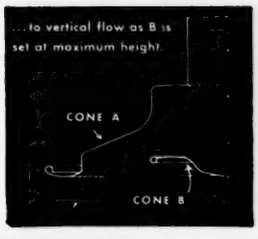

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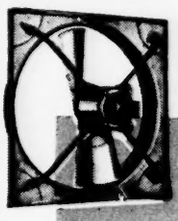

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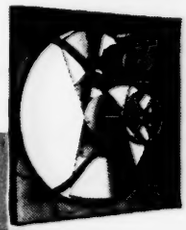
Herman Nelson Belt Drive Propeller Fans



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NEWS BRIEFS

(Continued from page 106)

• A set of standards covering the use of flat aluminum sheet in the manufacture of *fuel oil storage tanks* has been issued by Underwriters' Laboratories, Inc., based upon work by aluminum producers and tank manufacturers in an attempt to circumvent the steel shortage.

• Factory sales of *mechanical coal stokers* of all sizes and types amounted to 4,826 units in April, a decrease of 10% from the March figures but an increase of 14% over the number of units sold in April of last year.

• The Federal Power Commission has approved the application of Trans-Continental Pipe Line Company for construction of a new *1,840-mile pipeline* to bring Texas natural gas to the Philadelphia, New Jersey and metropolitan New York areas. Condition of the Commission approval is that the line must be complete by October 1, 1950.

• Figures resulting from a national poll and released by V. W. Blackney of U. S. Radiator Corp. show that approximately 30.8% of new houses built this year will have *hot water systems* while 19.9% will have *steam heating installations.*

• The all-time record of *new dwelling units* started in any one month under FHA inspection was established in April with a total of 35,555 units.

• Recognizing the need for re-examining the traditional basis for assigning materials to housing, the National Bureau of Standards has developed an *engineering approach to house design* to facilitate the use of unconventional material and unusual methods of construction. BMS Report 109, Strength of Houses, available for $1.50 a copy, describes the principles. The report can be obtained only from the Superintendent of Documents in Washington.

• Texas Gas Transmission Corp. has filed application with the Federal Power Commission for construction of an *840-mile pipeline* from Texas to Ohio to deliver natural gas to companies serving Kentucky, Ohio and Philadelphia.

• Breaker slate, a by-product of anthracite mining, has been found by the Lehigh Materials Co. to be a useful raw material for the manufacture of *light weight aggregate.* The aggregate, sold under the trade name of Lelite, is cellular in structure and has high insulation and sound absorbing qualities. It can be used with cement and water to form concrete and is adaptable for refractory applications. It is also used in poured structural concrete and special precast products.

WHAT READERS SAY

Fire Hazard of Steam Pipe

EDITOR, HEATING AND VENTILATING:

"Experience is my Classroom" articles by T. W. Reynolds are most enlightening and most interesting, and in fact are read first when receiving my copy of H & V.

I have one problem which seems to always cause an argument and I would like to have your views and experience on these questions.

1. Is it possible, with a low pressure domestic one pipe steam heating system, to cause a fire when exposed steam piping is close to or touching wooden floor joist or wooden floors?

2. Would it be possible to have the canvas outside covering, over 1 in. 4-ply asbestos air cell insulation, catch fire (outside of a brick-wall boiler room, 10 ft from boiler), without any signs of fire inside the boiler room?

This condition was reported by failure of low water cut-off, causing oil burner to continue in operation in an apparently dry steam boiler for a considerable length of time. There was absolutely no damage to C.I. boiler, sections, covering, or anything in the boiler room.

Please realize that you are not being questioned for legal reasons, but purely, to settle many arguments. A "yes" or "no" answer would be sufficient, if skeptical, but I would appreciate hearing of some of your experiences in this connection.

New York, N. Y. *E. Y.*

Questions by E. Y. were submitted to T. W. Reynolds. His comments to these two queries follow:

1. When close to wood (some regulations say not closer than ½ in., others 1 in.) there is some convection in unconfined spaces to remove heat, but even so, radiation is left. Underwriters have produced fires upon trial, especially in concealed spaces. The wood or combustible material chars, more or less, over a long period of time, until the ignition point is reached. Even though the pipe is 1 in. away, the Underwriters want the pipe to be insulated.

2. For the conditions stated, the answer is definitely, no. You say that the boiler was not damaged, but is it very red inside and is there any evidence of warped sections? If so, there is no damage, but trouble may develop if ever the boiler is taken apart and is then assembled. It is assumed that the boiler is a rectangular cast iron unit. As long as the cold or return water is not returned while the boiler is hot, the boiler will not crack, although it will warp a bit and will develop a red color inside.

The pipe insulation will protect the canvas from the hot pipe. A pipe that is that far away cannot get that hot. Steam will relieve at the safety valve setting of 5 to 15 lb and this would keep the temperature down

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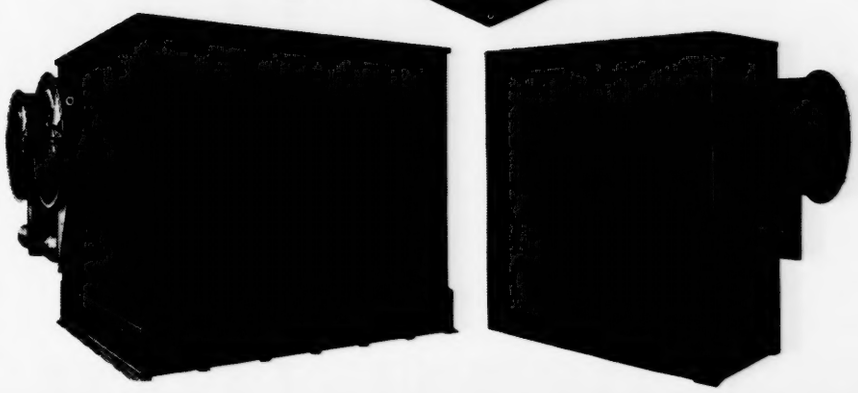

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Bulletin 220 describes this set as well as other styles and components. Write for it!

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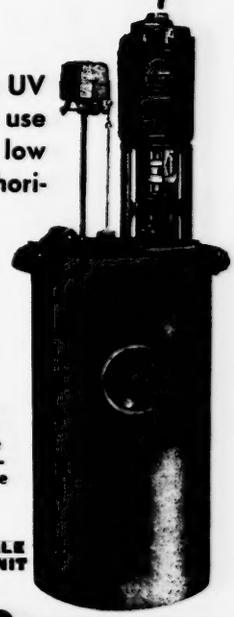

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in the boiler room until all the water is evaporated from the boiler and the boiler room. If the canvas burned, it must have been near a hot breeching.

One man thought he could drain his own heating system in the winter. He did so, but by oversight the boiler switched on. The man returned in a few weeks, found his oil tank empty and his insulated cast iron round boiler in apparently good condition. However, upon examination of the inside, he found the boiler shell all melted down. Nothing, however, caught fire.

If your boiler was not even reddened on the inside, it is even greater evidence of the lack of oven heat.

The writer has a canvas covering pipe insulation that almost touches the breeching in his home. In time it charred but never caught fire. Temperature in the breeching is 550F, and for the heat in the pipe to pass through the insulation, the temperature would have to be many times higher. The modern pipe covering with white glaze finish avoids the use of canvas and has the approval of the Underwriters.

Getting Personal

M. W. First

Melvin W. First (*Factors in the Design of Cyclone Dust Collectors*, page 79) is a a native of Boston, Mass., who received his degree of B.S. in Public Health from Massachusetts Institute of Technology in 1936.

He served as industrial hygiene engineer with the Detroit Department of Health and later with the Michigan State Health Department. He was five years in the U. S. Army as Major of Anti-aircraft Artillery, and part of that time was spent instructing the Chinese Army in the use of American Lend-Lease equipment. In 1947 he received his M.S. in Sanitary Engineering from Harvard University.

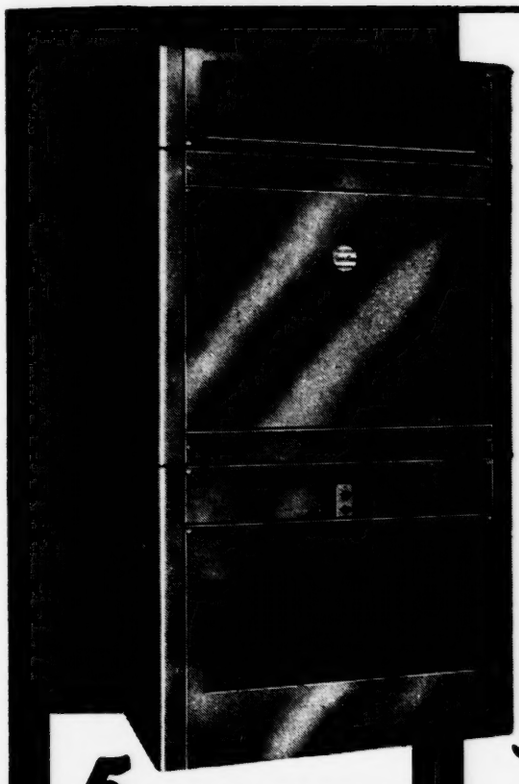
At present Mr. First is on a U. S. Public Health Research Fellowship doing research in industrial hygiene ventilation at Harvard.

Dr. Leslie Silverman (co-author of *Factors in the Design of Cyclone Dust Collectors*, page 79) is assistant professor of industrial hygiene, Harvard School of Public Health. He is the author of a number of factual articles in his field which have been published in HEATING AND VENTILATING. His biography appears on page 122 of the December, 1945 issue.

W. E. Langlois

Walter E. Langlois (*Shielding Fan System from Corrosion*, page 70) graduated in 1933 from Wentworth Institute, where he studied architectural construction. After graduation he spent two years in the construction industry, employed by the W. G. Handley Co. as a draftsman and the Davidson Construction Co. as a materials estimator. He also worked for a time with the civil engineering firm of Everett Dawst conducting topographical surveys.

In 1937 he joined the B. F. Sturtevant Company as a draftsman, transferred to the Industrial Department, where he specialized in dust and



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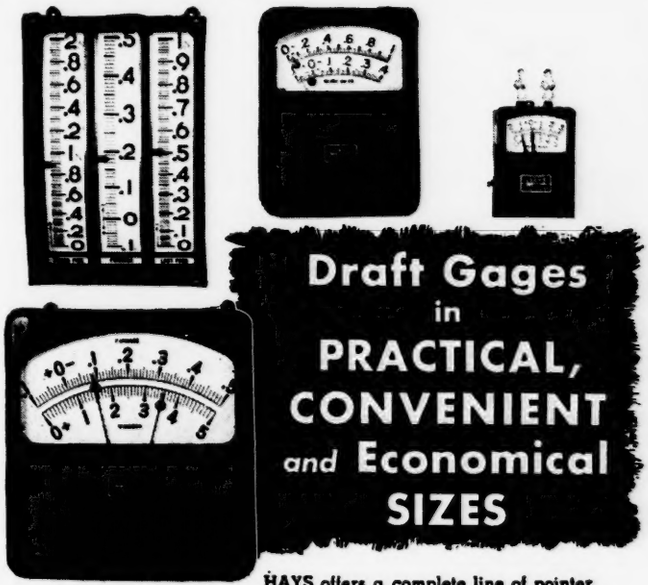

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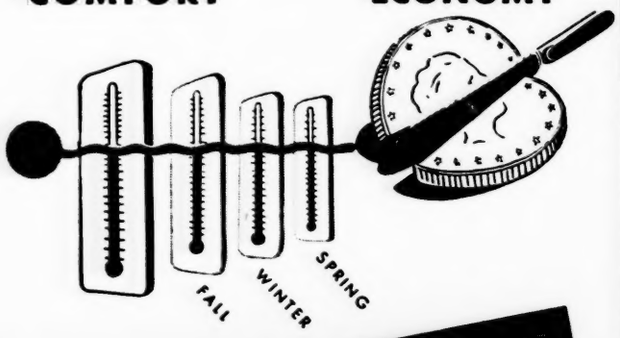

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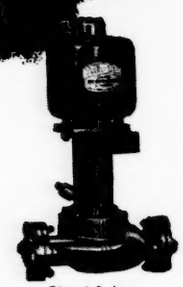
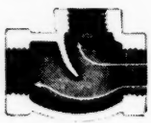
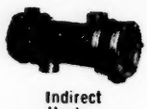


Direct Drive Circulators

Flow Control Valves



One-Pipe Distributors



Indirect Heaters

Relief and Pressure Reducing Valves

Triplex

HEATING SPECIALTY CO., INC.
PERU, INDIANA

In addition to units illustrated, the Triplex line includes—Direct Drive Horizontal Circulators, Indirect Drive Circulators, Expansion Tanks, Air Eliminators, Water Mixing Valves, Air Vent Valves, Tankless Heaters, Control Units, Electrical Controls, Barometric Draft Dampers, Sump Pumps.

SEE YOUR WHOLESALER TODAY

fume control, and is now headquarters staff assistant, Sturtevant Division, Westinghouse Electric Corp. He lectures to Westinghouse, Sturtevant Division, sales engineering students on dust and fume control, and related problems.

. . . Since the Last Issue

At the annual stockholders meeting of **C. A. Dunham Co.**, the following directors were elected for the ensuing year: **L. P. Dwyer**, president, Dwyer Products Co., Michigan City, Ind.; **Edward G. Bremner**, president, Bremner Bros. (Biscuit Co.) Chicago, Ill.; **H. H. Wright**, sales engineer, Kansas City, Mo.; **F. E. Schmidt**; and **H. S. Marshall**. At the directors meeting officers were elected as follows: **H. S. Marshall**, president; **F. E. Schmidt**, vice-president and treasurer; **L. D. Mandell**, vice-president; and **L. C. Murtaugh**, secretary.

American Air Filter Co., Inc., Louisville, Ky., has recently announced the appointment of **Merle K. Rush** as sales representative for the Omaha, Neb., territory. A native of Salem, Ind., he received his B.S., M.F. from Purdue University in 1933. Following his graduation, Mr. Rush joined the American Air Filter Co. in 1934 and spent a year in a special laboratory training course, at the end of which he became affiliated with Independent Air Filter Company as an engineer. At the time of Independent's consolidation with American Air Filter in 1938, Mr. Rush returned to Louisville and was active in the development of the Electro-Matic electronic precipitator.

M. K. Rush

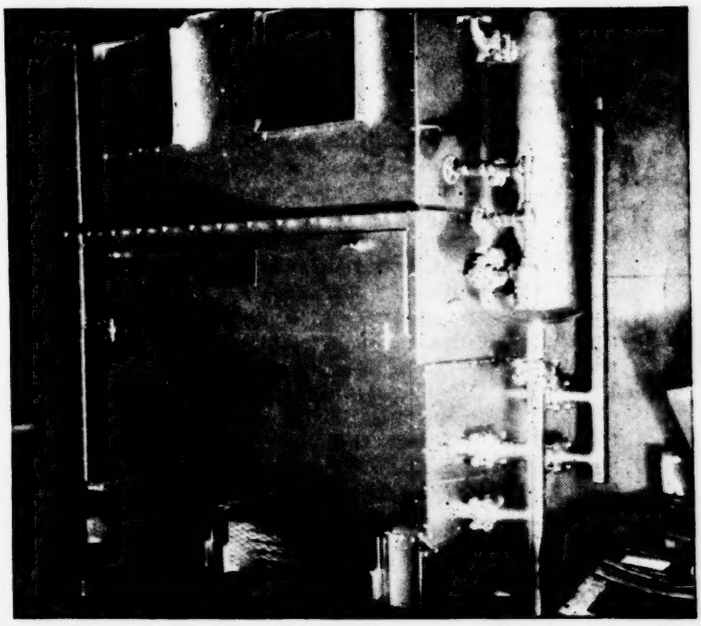
The Holtzer-Cabot Division of the First Industrial Corp. has been purchased by **Redmond Co., Inc.**, of Owosso, Mich., manufacturers of fractional horsepower motors. Holtzer-Cabot Electric Co., located in Boston, Mass., is one of the oldest manufacturers of motors, having been in existence almost 75 years and is well known as specialists in the development and manufacture of fractional horsepower motors. Frank C. Campbell, president of Redmond Co., Inc., will assume the direction of both companies, and Holtzer-Cabot will be known as Holtzer-Cabot Division of Redmond Co., Inc.

David L. Fiske has opened an office as consulting engineer in refrigeration, quick freezing, food preservation, air conditioning, insulation and allied fields at 111 Broadway, New York 6, N. Y. Mr. Fiske received his B.S. in mechanical engineering at Massachusetts Institute of Technology, an M.S. in thermodynamics at the University of Illinois, and a Ph.D. in industrial engineering at Columbia University. He has published treatises on humidity in refrigeration, low side principles, refrigerants, and other items, and was editor of seven editions of the Refrigerating Data Book.

Minneapolis-Honeywell Regulator Co. has opened a branch office at 265 Church St., New Haven, Conn., under the managership of **L. W. Shepard**, who has been transferred from the Hartford branch office. The New Haven office will handle air conditioning sales and service only.

Robert L. Hanson has been engaged as manager of the **Allen-Bradley** office in Pittsburgh, Pa. He is a graduate in electrical engineering of the University of Wisconsin, and has had extensive industrial engineering experience with Wagner Electric Corporation, Crocker-Wheeler Co., and Sperry Corp.

NIAGARA "NO-FROST" METHOD GIVES INCREASED FROZEN STORAGE CAPACITY



Successful Niagara NO-FROST Method installations in chilling of fresh foods and quick freezing of fruits, vegetables, fish, meats, and ice cream hardening prove many advantages:

- No frost or ice at any time . . . increases capacity and lowers cost. There is no loss of capacity during frost accumulation and no interruption for defrosting.
- Versatility for freezing or chilling bulk or packaged products establishes lower initial cost.
- Narrower spread between head pressure and suction pressure assures lower power consumption by refrigeration machinery.
- Rapid chilling or freezing and accurate control of temperature assures finest quality in any food.

Write for Bulletin 83-HV

NIAGARA BLOWER COMPANY

Over 30 Years' Service in Air Engineering

405 Lexington Ave., New York 17, N. Y.

Field Engineering Offices in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING **NIAGARA** HUMIDIFYING • AIR ENGINEERING EQUPT.

Automatic **REZNOR** GAS FIRED UNIT HEATER

JUST 3 MORE MONTHS UNTIL HEATING SEASON

RECOMMEND REZNOR HEATER INSTALLATION NOW

Your recommendation to modernize *now* with Reznor automatic unit heaters will be appreciated next winter. Advise installation before the pre-winter tie-up of tradesmen. Advise against the inconvenience of heating-season changes. Reznor gas fired units solve heating problems for any size buildings—from the corner drug store to the mammoth factory.

IT CIRCULATES SUMMER AIR

Reznor units have no idle season. Summer air is circulated by the BIG, QUIET FAN. Abundant heat is evenly distributed where you want it in winter.

ECONOMICALLY AUTOMATIC

Write, today, for a description and details of the REZNOR AUTOMATIC, GAS FIRED UNIT HEATER.

REZNOR *Gas fired unit heaters* SUSPENDED OR FLOOR MODEL

A SIZE FOR EVERY NEED

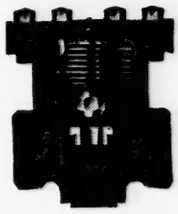
REZNOR CO. MERCER 9, PENNA.

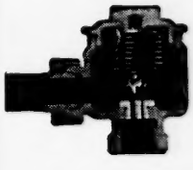
GAS FIRED HEATERS SINCE 1888

NO BOILERS • NO STEAM LINES
NO FUEL STORAGE • NO FIRE TENDING

More Service Tests Confirm that Nicholson Steam Traps Furnish . . .

2 to 6 Times MORE DRAINAGE Capacity





Recent comparative tests by large users of steam traps again showed the unequalled drainage capacity of Nicholson traps. The record low for steam waste was also shown. Some Nicholson features: larger valve orifice; operate on lowest temperature differential; no freeze-ups; no adjustment of valve or seat.

Put a Nicholson Trap on Test

See why leading plants are increasingly standardizing on Nicholson steam traps. We'll gladly send one for testing. 5 types for every application: size ¼" to 2"; pressure to 225 lbs. BULLETIN 1047.

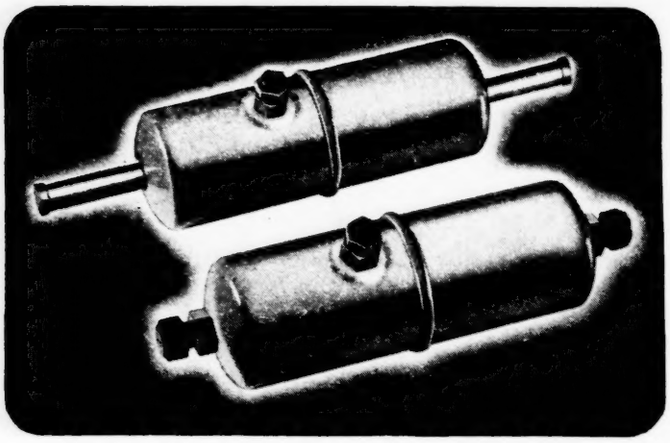
W. H. NICHOLSON & CO. 199 OREGON STREET WILKES-BARRE, PA.

Valves • Traps • Steam Specialties

NOW... Keep Larger Systems Moisture-Free, Dirt-Free ...

Install New Large-Capacity, Rechargeable

TRAP-DRI DRIER FILTER STRAINER

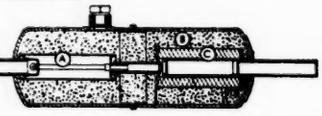


● With a rating up to 5 tons Freon these new larger A-P TRAP-DRI Drier-Filter-Strainers give you a welcome "break" on cleaning out larger systems, as well as providing for those small systems which need a larger capacity drier for preliminary cleanout. Now all your systems up to 5 tons Freon may be given the *extra protection* that means so much to improved system efficiency, avoidance of common troubles and service difficulties due to moisture, dirt, solder particles, scale, sludge and other impurities.

The new larger A-P TRAP-DRI starts cleaning up your system immediately. Offering *minimum pressure drop*, it provides a filter unit as effective as a 900-mesh strainer (removing materials as small as 5 microns in size) . . . *plus* a highly-efficient and adequate charge of Silica Gel —53.7 cubic inches. This *drying agent may be removed and replaced, or dried out and re-used.*

Install the new A-P TRAP-DRI in your larger refrigeration systems — for improved operation, savings in service time, greater satisfaction and cost-savings for your customers. You'll find them at leading refrigeration wholesalers — or write for latest bulletins.

VERSATILITY IN INSTALLATION



The new TRAP-DRI is supplied in two types: Model DF-4, with ½" male flare; or DS-5, with ⅜" sweat connection. They may be easily connected to ⅜", ½", ⅝", ¾" or even ⅞" tubing if desired. This ready versatility makes the new TRAP-DRI adaptable to a wide variety of systems.

Cross Section showing:
(A) Screen at inlet diffuses refrigerant into Silica Gel.
(B) Silica Gel drying agent (53.7 cu. in.)
(C) Honeycomb filter element traps impurities as small as 5 microns, by depth filtration principle.

AUTOMATIC PRODUCTS COMPANY
2462 North Thirty-Second Street
Milwaukee 10, Wisconsin
Export Dept., 13 East 40th Street, New York 16, N. Y.

R704

DEPENDABLE REFRIGERANT VALVES

STOCKED AND SOLD BY GOOD REFRIGERATION WHOLESALERS . . . RECOMMENDED AND INSTALLED BY LEADING REFRIGERATION SERVICE ENGINEERS

Wilson C. Blake, Co., 190 Beacon St., Hartford, Conn., has been appointed distributor of Dravo "Counterflo" heaters in Connecticut and Western Massachusetts, by **Dravo Corp.,** Pittsburgh, Pa.

General Controls Co., has announced the promotion of **Mel W. Lewis** to branch manager of the Cleveland, Ohio, factory branch office. Mr. Lewis has been associated with General Controls Co. in San Francisco for the past ten years.

Wilson & Co., Inc., 4100 So. Ashland Ave., Chicago, Ill., manufacturers of Wilson hair filters, have announced the appointment of **Robert M. Seepe** as manager of hair filter sales. He succeeds A. C. Andresen, who will soon announce his connection with a western firm. Mr. Seepe received his B.S. degree in industrial administration from the University of Illinois and his M.S. degree in distribution and statistics from Northwestern University. He became a member of the Wilson organization in 1936 to head up a market analysis department which made a study of production and market trends. In 1940 he became assistant to J. A. Hamilton, vice-president in charge of branch house sales. Mr. Seepe's headquarters will be in Chicago.

R. M. Seepe

Headquarters of the **National Heating Wholesalers Association** has been moved to 239 Water St., Pittsburgh 22, Pa.

Verne O. McClurg, partner in the Chicago architectural and engineering firm of Mundie, Jensen and McClurg, was installed as president of the **Western Society of Engineers** at the Society's annual meeting.

The appointment of **Philip N. Dutton,** Cleveland, Ohio, as a company sales supervisor in Ohio and parts of Pennsylvania has been announced by the **Research Products Corp.** of Madison, Wis. The company also announces the promotion of **John Schutz** of its Cleveland office to an administrative position at the Madison headquarters

Dr. Charles E. Lawall, assistant vice-president and engineer of coal properties of the Chesapeake and Ohio Railway Co., has been appointed permanent chairman of the Mining Development Committee of **Bituminous Coal Research, Inc.**

A. L. Kiewit, for more than twenty years associated with the Cincinnati Gas and Electric Co., has been appointed assistant director of engineering for the **Coal Producers Committee for Smoke Abatement.** One of Mr. Kiewit's first assignments with the Coal Producers Committee for Smoke Abatement will be to direct the field work of the program now in full swing to make Columbus, Ohio a "model" city insofar as smoke is concerned.

Stevens Institute of Technology conferred the honorary degree of Doctor of Engineering upon **Ernest H. Peabody,** president and founder of **Peabody Engineering Corp.** at their regular June Commencement exercises. Dr. Peabody has long been active in the development and perfection of combustion equipment and introduced the first combined gas and oil burner that permitted the economical burning of either gas or oil together or singly. In addition, Dr. Peabody invented and perfected the wide-range mechanical atomizing fuel-oil burner, the combined pulverized coal and oil burner and later produced the first combined burner for liquid gases and pulverized fuels. With more than a half century of research and engineering behind him, Dr. Peabody holds more than thirty patents.

Edgar A. Wilcox, of E. A. Wilcox Company, San Francisco, has been announced as president of **Manufacturers' Agents National Association,** by its executive secretary P. Edwin Thomas from his field office at 542 South Broadway, in Los Angeles. Mr. Wilcox is author of the McGraw-Hill text on "Electric Heating," and also contributor of technical articles to magazines. **W. S. Kirkpatrick,** well known in domestic and export circles, a member of the Advertising Club of New York and the Committee on International Trade, is the executive treasurer, who operates from the association's interim headquarters office, at 50 East 42nd St., in New York. Manufacturers' agents everywhere are being invited to write the executive secretary in Los Angeles for a new 20-page M.A.N.A. information booklet.

Rensselaer Polytechnic Institute has awarded its 1948 Demers Medal to **Leverett C. Stone,** 1709 Foxhall Road, N. W., Washington, D. C. The medal is awarded annually by R. P. I.'s trustees in recognition of distinguished service for the college by an alumnus. Mr. Stone was graduated at R.P.I. as an electrical engineer in 1914 and is now a partner in the Stone Heating and Ventilating Company, 3245 Q St., N. W., Washington, D. C.

Gilbert Associates, Inc., engineers and consultants in construction, power generation, industrial engineering and allied fields, have opened an office in the Oil and Gas Building, Houston, Texas. This is the sixth regional office to be opened by this company, including one in Manila, P. I. A recently issued brochure describes activities and the 40-year history of the organization.

Air Filter Corp. has tripled manufacturing space by taking over new quarters at 108 N. Water St., Milwaukee 2, Wis. The company manufacturers Aircor air filters, grease filters and welder filters for heating, ventilating and industrial use.

The Marley Co., Inc., manufacturers of cooling towers, water cooling equipment and spray nozzles, announces the opening of a new district office in Philadelphia at 1112 Packard Building. **Robert M. Sharp** is in charge.

J. C. Haas

John C. Haas, secretary of **United States Radiator Corp.,** has been elected a vice-president in addition to his present office. Mr. Haas, an employee of the company for 38 years, was named production manager in 1946 after serving as assistant to the general sales manager and assistant to the manager of the operating department. U. S. Radiator has also announced the following new appointments: **R. W. Dickson** has been appointed manager of the Capitolaire Division, winter air conditioning products, with headquarters at the company's main office in Detroit; **A. J. Reebel,** formerly manager of the Capitolaire Division has been appointed acting manager of the company's branch at Cleveland, Ohio, with offices at 5512 Euclid Avenue; **A. X. Bergeron** has been named acting manager of the company's branch at St. Louis, Mo., with offices at 486 Arcade Building.

Appointment of **John F. O'Donnell** as sales manager for **Stokol Stoker Co., Inc.** of Indianapolis has been announced. Mr. O'Donnell has been with Stokol for ten years. Prior to his appointment as sales manager he was assistant general manager of the company.

Bailey Meter Company, Cleveland, Ohio, has opened a new branch office in Charlotte, N. C., in Room 1004, Independence Building. **J. R. Powell** has been appointed branch manager.

Free! This Valuable Folder describing "Z-CRETE"...THE NEW TESTED SYSTEM FOR Insulating Underground Pipes

LOW COST . . . NO CRITICAL MATERIAL REQUIRED!

Voids, cracks, heat-loss, moisture deterioration—the headaches of underground insulated pipe jobs—are eliminated by Z-Crete*, the new, monolithic, permanent insulating system that can't rot or deteriorate.

Read about it in this folder. It explains fully this sensational new way of doing a tough job. It contains easy-to-follow drawings of construction details. Best of all, it's free to you. Here is something you must have in your files.

ZONOLITE COMPANY
135 S. LaSalle Street
Chicago 3, Illinois

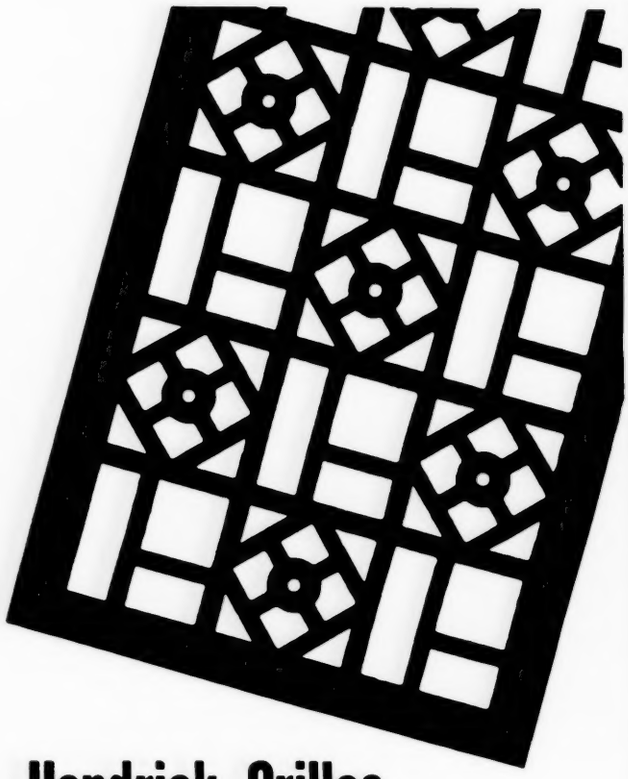
**Z-Crete is the registered trademark of the Zonolite Company.*

Zonolite Company, Dept. HV-78, 135 S. LaSalle St.
Chicago 3, Illinois
Please send me your free folder on Z-Crete.

Name.....

Address.....

City..... State.....



Hendrick Grilles for modern interiors

Many unusual decorative effects, for modern interiors, are obtainable through the use of Hendrick Grilles. Over a hundred designs, many originally produced to meet an architect's specifications for some outstanding building, are available.

Made from heavy-gauge metal, each design can be supplied in a wide range of overall dimensions, bar sizes, number of perforations and size of perforations. Ample open areas assure good air flow.

There is a wide choice of metals from which the grilles may be fabricated—aluminum, brass, bronze, copper, Monel, steel, stainless steel.

Sizes are accurate, perforations clean-cut, and there are no burrs or other imperfections. Installation is easy, because a special flattening operation in their manufacture gives the grilles uniformly flat surfaces.

Perforated Metals
Perforated Metal Screens
Architectural Grilles
Mitco Open Steel Flooring,
"Shur-Site" Treads and
Armorgrids

HENDRICK
Manufacturing Company
42 DUNDAFF STREET, CARBONDALE, PA.
Sales Offices in Principal Cities

Edward M. Borger, president of The Peoples Natural Gas Co., has been elected a director of **Dravo Corp.** Mr. Borger has been president of The Peoples Natural Gas Co. since 1940 and is a director of that company and the Consolidated Natural Gas Co. He started with Peoples as a stenographer and secretary, attended night law school at Duquesne University and was admitted to practice before the Pennsylvania Bar in 1922. He was attorney for Peoples and the Hope Natural Gas Co. until 1935 when he became chief counsel for two other companies, New York State Natural Gas Co. and River Gas Co. In 1942, Mr. Borger took a leave of absence from his post with the gas company to enlist in the American Field Service for duty in the Middle-East during the war.

Howard A. Turner has been appointed manager of the Merchandised Products Division of **Herman Nelson Corp.,** Moline, Ill., manufacturers of heating and ventilating products. Mr. Turner will coordinate the activities of all departments of the company to further the development and marketing of its products. Mr. Turner was at one time southwest regional manager and later national commercial sales manager of the Nash-Kelvinator Corp. Before joining the Herman Nelson Corporation he was manager of the Waste Foods Disposer Division of Eureka Williams Corp.

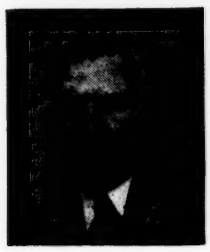
H. A. Turner

General Controls, manufacturers of automatic temperature, pressure and flow controls announce the opening of a new and enlarged Denver factory branch office at 1162 Elati St., Denver 4, Colo.

John W. Akins, Jr. has been appointed central division manager of **Comfort Equipment Corp.,** Chicago, national sales agent for Freeman Stokers, Quaker and Comfort heating products.

Turner Construction Co. with offices in Boston, New York and Philadelphia announces the opening of a Chicago office located in the Bankers Building, 105 West Adams St.

The appointment of **Walter G. Schlichting** as sales manager of the Heating, Cooling & Air Conditioning Division of the **Young Radiator Co.** has been announced. Mr. Schlichting is a graduate of the University of Illinois, and prior to joining the Young Radiator organization was manager of the Air Conditioning Division of Clarage Fan Co., Kalamazoo, Mich. Mr. Schlichting is a registered professional engineer in the State of Michigan and is past president of the Western Michigan Chapter of ASHVE.



W. G. Schlichting

James M. Todd, New Orleans consulting engineer, was nominated as the next president of **The American Society of Mechanical Engineers** at the semi-annual meeting. His name heads a slate of new officers, including several regional vice-presidents and directors-at-large, submitted by the nominating committee. Other officers nominated as regional vice-presidents are: **Arthur Roberts, Jr.,** chief engineer, Lynchburg Foundry Co., Lynchburg, Va.; **Forrest Nagler,** chief mechanical engineer, Allis-Chalmers Mfg. Co., Milwaukee; **Carl J. Eckhardt,** professor of mechanical engineering and superintendent of utilities, University of Texas, Austin, and **Albert R. Mumford,** development engineer, Combustion Engineering Co., New York.

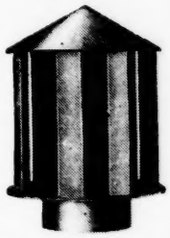
ON CHIMNEYS AND VENT FLUES

Breidert Air-X-Hausters

(PAT. NO. 2269428)

Breidert Air-X-Hauster Chimney Top makes fireplace draw better.

the first scientific improvement in roof ventilators in over 50 years!



Type B Breidert Air-X-Hauster for factories, commercial and residential buildings.

No matter which way the wind blows, no matter how bad the weather—the Breidert *provides positive exhaust.* Designed in accordance with the science of aerodynamics, this revolutionary ventilator utilizes the power of air currents coming from *all angles* to provide safe, positive ventilation without back-draft. Stationary—no moving parts to regulate or get out of order... no power consumption... compact and pleasing in appearance.

Breidert Air-X-Hauster—the first ventilator to be tested under all variable vertical and horizontal wind conditions . . . with certified ratings published.

Unlike most conventional ventilators which work efficiently only when wind strikes in a horizontal plane, the Breidert has been thoroughly tested—by U. S. Navy and Smith Emery Commercial Testing Laboratories—with the wind blowing in *all* directions. Its remarkably high performance ratings under all conditions are *certified and published.*

Many Thousands in Use all over the Country

Breidert Air-X-Hausters have found wide acceptance among architects, engineers, industrialists, farmers, home owners, ship and boat owners, U. S. Army, U. S. Navy, Maritime Commission, schools, institutions and public buildings. In every case when properly installed, the Breidert has never failed to fully meet every claim made for it!

Free Engineering Data Book, with complete specifications, sent on request. Address

"Ask to see this interesting demonstration"

G. C. BREIDERT CO.,
3129 SAN FERNANDO ROAD
LOS ANGELES 41, CALIFORNIA

Representatives in 30 principal cities throughout the United States.

A Better STRAINER

- Cadmium Plated For Protection Against Corrosion and For Better Appearance
- High-Grade Woven Monel Wire Screen
- Readily Removed Steel Blow-Off Bushing
- Screen and Bushing Come Out Together — Go Back Together, Automatically Aligning
- For Steam Lines or Water, Oil and Other Fluids
- Reasonably Priced
- 6 Sizes from ½" to 2" for Pressures up to 600 lbs
- Many Thousands in Service
- Sold by Nearly 1150 Mill Supply Houses

See Your Supply House or Send for Bulletin S-201

YARNALL-WARING COMPANY
104 MERMAID AVE., PHILADELPHIA 18, PA.

YARWAY STRAINERS